Lund 1972

Erik Trell

PULMONARY HYPERTENSION

and

ASSOCIATED CONDITIONS

Inventory of a right heart catheterization material.

Malmö 1972

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PULMONARY HYPERTENSION AND ASSOCIATED CONDITIONS
INVENTORY OF A RIGHT HEART CATHETERIZATION MATERIAL

AKADEMISK AVHANDLING

som med vederbörligt tillstånd av Medicinska Fakulteten i Lund för vinnande av medicine doktorsgrad kommer att offentligen försvaras i universitetsklinikernas aula, Allmänna sjukhuset i Malmö, tisdagen den 30 maj 1972 kl. 9.15

av

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Malmö 1972

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INVENTORY OF A RIGHT HEART CATHETERIZATION MATERIAL

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To Lena

This thesis is a summary of the following publications:

I E. Trell: PULMONARY HYPERTENSION IN CONGENITAL SHUNT DEFECTS. Observations in a right heart catheterization material with particular reference to occurrence, natural history and prognostic implications in adolescence and adulthood. Also appearing in Supplementum 535 of Acta Med. Scand.

II E. Trell: PRIMARY AND CHRONIC THROMBOEMBOLIC PULMONARY HYPERTENSION. Nosologic spectrum. To appear in Angiology.

III E. Trell & C. Lindström: PRIMARY AND CHRONIC THROMBOEMBOLIC PULMONARY HYPERTENSION. Clinical and pathoanatomic observations. Also appearing as Supplementum 534 of Acta Med. Scand.

IV E. Trell: PULMONARY HYPERTENSION IN LUNG DISORDERS. Some findings in a heart catheterization material. Also appearing in Supplementum 535 of Acta Med. Scand.

V E. Trell: PULMONARY HYPERTENSION IN MITRAL VALVULAR DISEASE AND HEART CONSTRICTION. With particular reference to the different pulmonary hemodynamic patterns and notes on prognostic implications. To appear in Cor et Vasa (Praha).

VI E. Trell: PULMONARY HYPERTENSION IN DISORDERS OF THE LEFT HEART. Observations in a catheterization material. To appear in Scand. J. Clin. Lab. Invest.

VII E. Trell, B.W. Johansson, F. Linell & J. Ripa: "FAMILIAL PULMONARY HYPERTENSION" AND MULTIPLE ABNORMALITIES OF LARGE SYSTEMIC ARTERIES IN OSLER'S DISEASE. To appear in Amer. J. Med.

VIII E. Trell, B.W. Johansson, L. Andrén & N.-M. Ohlsson: THE SCIMITAR SYNDROME. With particular reference to its pathogenesis. Z. Kreisl.-Forsch. 60:880, 1971.

IX E. Trell, A. Rausing, A. Torp, J. Ripa & J. Waldenström: CARCINOID HEART DISEASE. With remarks on investigative findings, natural history and pulmonary hypertension. To appear in Amer. J. Med.

X E. Trell: PULMONARY ARTERIAL ANEURYSM. With remarks on pulmonary hypertension, natural history and possible disturbance of pulmonary parenchymatous function. To appear in Thorax.

XI E. Trell & A. Rausing: CARDIOVASCULAR COMPLICATIONS IN MALIGNENT THYMOMA. With remarks on pulmonary hypertension. To appear in Acta Med. Scand.

XII E. Trell & C. Lindström: PULMONARY HYPERTENSION IN SYSTEMIC SCLEROSIS. Ann. Rheum. Dis. 30:390, 1971.

XIII J. Malmquist, E. Trell, A. Torp & C. Lindström: A CASE OF DRUG-INDUCED (?) PULMONARY HYPERTENSION. Acta Med. Scand. 188:265, 1970.

XIV E. Trell: BENIGN, IDIOPATHIC PULMONARY HYPERTENSION? Two further cases of unusually long duration. To appear in Acta Med. Scand.

XV B.W. Johansson, A. Torp & E. Trell: PROLONGED AMBULATORY OXYGEN THERAPY IN PULMONARY HYPERTENSION OF VARIOUS ETIOLOGY. Acta Med. Scand. 189:155, 1971.

These papers will be referred to by the above Roman numerals.

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INTRODUCTION

It can be appropriately stated, that pulmonary hypertension offers a large and complex subject. It may also be stated, that earlier single studies of pulmonary hypertension mostly concern a particular variety of it, or a particular clinical, pathoanatomic, pathophysiologic or investigative aspect relating to it. However, Ljungdahl (1915) earlier performed a thorough study of the full range of pulmonary arteriosclerosis in a pathological material from Malmö General Hospital, and it was considered worth-while to extend now from the same hospital a similar, general approach to the study of pulmonary hypertension in a total, right heart catheterization material assembled during 20 years at the Heart Laboratory of the Medical Clinic in Malmö. Further motives, purposes and aims of this study will be given later.

The historic development of the concept of pulmonary hypertension will be omitted in the present summary. Some notes have been given in separate articles (I, II, V), and it might be concluded that "pulmonary arteriosclerosis" (atherosclerosis, arteriolosclerosis, atherose), pathoanatomically (Posselt, 1909), clinically (Posselt, 1908) and pathophysiologically (Tigerstedt, 1902) well delineated already in the nineteenth century, essentially covers the same nosologic range. Similarly, some of the more important, early hemodynamic studies founding the present knowledge of pulmonary hypertension have been referred to in the separate articles, and will not be repeated here. Three basic, current conceptualiazations of pulmonary hypertension will be briefly considered, however:

A. Definition of pulmonary hypertension.

For the purpose of the present study, the definition proposed by Wood (1956) was utilized, viz. "pulmonary hypertension literally implies a pulmonary blood pressure above 30/15 mm Hg, which is the upper limit of the normal range".

B. Classification of pulmonary hypertension.

There are two main ways of classificating pulmonary hypertension. One, as applied by Wood, is according to the physiological mechanisms that may produce an elevation of the pulmonary arterial pressure; into varieties like "passive, obstructive or obliterative, hyperkinetic and vasoconstrictive" pulmonary hypertension (Wood, 1956). The other way was proposed by Galland (1961), and relates to the anatomic site of the pathophysiologic process inducing the pulmonary hypertension. In the present study, this anatomic, or topologic, type of classification was utilized, since it was considered to offer a slightly more varied subgrouping of pulmonary hypertension, and a more firm and direct coupling with the many different cardio-pulmonary and circulatory disease conditions in which pulmonary hypertension may occur. With slight modification and extension of Galland's original scheme, the following classification of pulmonary hypertension was applied:

Topologic classification	Type(s) of related disease conditions	Pathophysiologic mechanism of pulmonary hypertension most likely to be primarily involved
1. Communication between the systemic and lesser circulations	a) Intracardiac shunt lesions b) Extracardiac shunts	Hyperkinetic
(2. Right heart)	a) Pulmonic stenosis b) Other right valvular lesions	(Right ventricular hypertension) (Pulmonary hypertension?)
3. Pulmonary arteries a) Central and large pulmonary arteries	a) External compression b) Mural lesions, (inflammatory, degenerative, neoplastic) c) Intra-luminal obstruction (e.g. large thromboemboli)	Obstructive - Obliterative
b) Peripheral pulmonary arteries	a) Reduction, e.g. in lung resection and parenchymatous destruction b) "Primary and thromboembolic pulmonary hypertension" c) Pulmonary parenchymatous disease	Relative hyperkinetic, obstructive? Obstructive, vasoconstrictive Vasoconstrictive, obstructive
c) Precapillary area and pulmonary capillaries	a) "Primary and thromboembolic pulmonary hypertension" b) Pulmonary parenchymatous diseases	Obstructive, vasoconstrictive Vasoconstrictive, obstructive
4. Pulmonary veins	Pulmonary venò-occlusive disease, mediastinal fibrosis, and others	Passive Obstructive? Vasoconstrictive?
5. Left atrium	(Atrial myxoma), mitral valvular disease, constrictive pericarditis, and others	Passive

6. Left ventricle	a) Myocardial diseases b) Left ventricular out-flow obstruction (aortic stenosis and others)	Passive
7. Systemic arteries	Systemic hypertension, coarctation of the aorta, Takayashu's disease, and others	Passive

The representation of the material and the ordering of the separate articles in general correspond with the order of this classification. Complementary functional reasoning is included in the respective sections.

C. Division of pulmonary hypertension.

There are two implications of this aspect:

1) The division of the pulmonary arterial pressure into its basic hemodynamical characteristics pertaining to the subject of pulmonary hypertension, such as the pulmonary arterial systolic, mean and diastolic pressures, the pulmonary capillary venous (PCV) pressure, the pulmonary vascular resistance (PVR) index, and the relation between the pulmonary arterial pressures, in particular the pulmonary arterial diastolic pressure, and the PCV pressure.

2) The division of the pulmonary arterial pressure characteristics in normal values and in increased values, as well as the subdivision of the latter into slight, moderate, pronounced and severe degree of elevation.

a. Pulmonary arterial systolic pressure.

WHO's expert committee gave an upper normal limit of the pulmonary arterial systolic pressure of 25 mm Hg, when measured at rest, in the recumbent position and with mid-thoracic line or corresponding levels as zero reference (Herles et al., 1963). An elevation of the pulmonary arterial systolic pressure is usually considered to be present, when it exceeds 30 mm Hg (Wood, 1956). Thus, systolic pulmonary arterial pressure $\leq$ 30 mm Hg was regarded normal in the present study, while, however, a pulmonary arterial systolic pressure between 26-30 mm Hg was considered "upper normal". This division accords with the findings in several normal materials (Motley et al., 1947; Werkö, 1947; Hellems et al., 1948; Johnsson, 1951; Doyle et al., 1952; Fowler, 1953; Klepzig, 1955; Barrat-Boyes & Wood, 1957; Sancetta et al., 1957; Sancetta & Kleinerman, 1957; Bevegård et al., 1960; Fishman et al., 1960; Denolin, 1961; Bergofsky et al., 1962; Bevegård et al., 1963; Granath et al., 1964; Granath & Strandell, 1964; Hultgren et al., 1965; Widimský et al., 196 Only during the first two-three weeks of post-natal life is the systolic pulmonary arterial pressure higher; falling rapidly from systemic levels to "adult" levels (Adams & Lind, 1957; James & Rowe, 1957; Rowe & James, 1957; Kjellberg et al., 1959; Saling, 1960; Rudolph et al., 1961; Dexter et al., 1964; Emmanouilides et al., 1964; Arcilla et al., 1966; I, fig. 12). Even in the aged patient, the resting pulmonary arterial systolic pressure normally remains largely unaltered (Dexter et al., 1964; Granath et al., 1964; Granath & Strandell, 1964; Emirgil et al., 1967).

Pulmonary arterial systolic pressures between 31-40 mm Hg may not be regarded as clear-cut pulmonary hypertension, but as "slightly elevated", since a number of studies show that various physiologic influences may exert a pulmonary arterial pressure-increasing effect, which rarely exceeds 10 mm Hg, however. Such physiologic influences include hypoxia (Motley et al., 1947; Werkö, 1947; Doyle et al., 1952; Fishman et al., 1960; Bergofsky et al., 1962) and exercise (Hellems et al., 1948; Barrat-Boyes & Wood, 1957; Sancetta et al., 1957; Sancetta & Kleinerman, 1957; Bevegård et al., 1960; Fishman et al., 1960; Holmgren et al., 1960; Denolin, 1961; Widimský et al., 1965).

Pulmonary arterial systolic pressures $\geq$ 41 mm Hg were subclassified in consecutive steps of 20 mm Hg into moderate (41-60 mm Hg), pronounced (61-80 mm Hg) and severe ($\geq$ 81 mm Hg) pulmonary hypertension.

b. Pulmonary arterial mean pressure.

It can be briefly stated that corresponding levels of the pulmonary arterial mean pressure are at about 10 mm Hg lower (Herles et al., 1963).

c. Pulmonary arterial diastolic pressure.

The pulmonary arterial diastolic pressure is rarely considered in material studies of pulmonary hypertension. Specifications of the normal range of the pulmonary arterial diastolic pressure are scant. Wood (1956) considered 15 mm to be the upper normal limit, and WHO's expert committee 12 mm Hg (Herles et al., 1963). In the normal materials referred to above, pulmonary arterial diastolic pressures rarely exceeded 13-15 mm Hg, and virtually never reached below 4-5 mm Hg. Further, there is experimental evidence of a critical closing pressure of the pulmonary vasculature of about this magnitude; i.e. 4-5 mm Hg (Harvey et al., 1971). 13-15 mm Hg might then be considered the upper normal limit of the pulmonary arterial diastolic pressure, and 4 mm Hg the lower limit.

d. Pulmonary capillary venous (PCV) pressure.

The PCV pressure was introduced by Hellems et al. (1948) and Lagerlöf (1949) & Werkö (1950), and is considered to reflect the left atrial pressure (Werkö et al., 1953; Falicow & Resnekow, 1970; Harvey et al., 1971). In the normal materials here referred to, PCV pressures ranged between 4.5 - 12 mm Hg, and, although WHO's expert committee stated 9 mm Hg as the upper normal value (Herles et al., 1963), many authors allow up to 12 mm Hg (Shine et al., 1968).

e. Pulmonary vascular resistance (PVR).

In the present study, pulmonary vascular resistance is expressed in units, according to the formula

$$\text{PVR (units)} = \frac{\text{pulmonary arterial mean pressure - PCV mean pressure (mm Hg)}}{\text{cardiac output (l/min)}}$$

The PVR index did not exceed 2.6 in any of the investigated cases in the normal materials here referred to. 2.5 units have been mentioned as an approximate upper normal limit in adults (Bristow et al., 1966). However, it is appreciated that normal values may vary because of differences in the cardiac output (Bristow et al., 1966), and, especially in left ventricular disorders, there is currently a tendency of allowing higher values, for instance, 4 (Shine et al., 1968) - 5 units (Rotman et al., 1971).

f. Pulmonary arterial diastolic - PCV pressure gradient.

Recently, the relation between the pulmonary arterial diastolic pressure

and the mean PCV pressure has been used instead of the PVR index in material studies as a more sensitive and graphically illustrative correlate to the relative contributions of the left atrial - left ventricular end-diastolic pressure and of factors superimposed on this to the regulation of the pulmonary arterial pressure (Harvey et al., 1971). A pulmonary arterial diastolic pressure gradient against the PCV pressure is suggestive of a component of precapillary pulmonary vascular obstruction in pulmonary hypertension, while identical levels or gradient from the PCV pressure against the diastolic pressure indicate "passive" pulmonary hypertension from elevation of the left heart (end-)diastolic pressure (Harvey et al., 1971).

PRESENT INVESTIGATION

Purposes and aims of the study.

1. Reliable epidemiologic conclusions are difficult to draw from a heart catheterization material. Still, since a comparable, general study of pulmonary hypertension within a sizeable, total right heart catheterization material is hitherto lacking, it was thought to be of interest to make an inventory of the occurrence of pulmonary hypertension in the various, major disease groups included in the series. Plausibly, a comparison of the relative pressure distribution in the disease groups might reflect some of their relative contribution to pulmonary hypertension in general.

2. Even if various selective mechanisms cannot for a certainty be excluded to operate in a heart catheterization material, and might tend to invalidate the accuracy of absolute frequency statements pertaining to the population in general, inclusion of the cases with normal pulmonary arterial pressures as well as the cases with consecutive levels of pulmonary arterial pressure increase in the study might allow some conclusions as to the relative significance of factors like age and sex of patients and, when possible to indicate, also of the disease duration, for the occurrence of pulmonary hypertension in the represented disorder groups. Thus, a comparison of the relative age and sex distribution in the various disease and pressure groups in the material, and, where this was possible, an evaluation of the approximate disease duration as related to the pulmonary arterial pressure level belong to the purposes of the study.

3. Prognostic significance of pulmonary hypertension within a sizeable, total heart catheterization material has not been studied before. Although a complete evaluation of prognosis requires a precise study of death causes, effects of applied treatment regimens and consideration of other clinical parameters to the disease severity, follow-up investigation and inter-comparison regarding cumulative crude mortality and survival from the time of catheterization of all cases in the material, both those with normal pulmonary arterial pressures and those with various degree of pulmonary hypertension, might still shed some light upon the prognostic implications of pulmonary hypertension in these disorders. Such an investigation therefore belongs to the aims of the present study, including brief evaluation of some factors possibly constituting particularly important contributory influences, such as the age of the patients, the results of performed operations, and the underlying hemodynamic characteristics of the pulmonary hypertension.

4. A fair number of the patients in some of the disorder groups in the material were subjected to re-catheterization, and an indication of some patterns in the natural history of pulmonary hypertension in these disorders also belongs to the aims of the study.

5. As an extension of this purpose, it was aimed at personally re-investigate those interesting cases of pulmonary hypertension in the 20-year material, who had not been subjected to re-catheterization during this time interval, or in whom further follow-up investigation was thought to be of particular interest. The re-investigation included physical examination and, when permission was granted, renewed right heart catheterization and additional investigative procedures to elucidate the nature of the pulmonary hypertension.

6. As briefly surveyed in the separate articles, pulmonary hemodynamic patterns in the major groups of pulmonary hypertension are extensively studied. Utilization of fairly recent possibilities of applying various regression analysis techniques in the evaluation of such fea-

tures in large materials of patients with pulmonary hypertension is sparse, however, and is entirely lacking in a sizeable, total heart catheterization series. In the present study, it was decided to pay particular attention to these methods, therefore. Mainly those features with a bearing upon the types and probable mechanisms of the pulmonary hypertension developing in the various diseases were studied, including the relation between pulmonary arterial systolic, mean and diastolic pressures to the PCV pressure, and the relation of pulmonary arterial systolic pressure to pulmonary blood flow and to the PVR index. Many of these relations have not been formularly substantiated before in large total materials or sizeable subgroups of pulmonary hypertension. Since the hemodynamic findings are thus graphically illustrated, it was decided to restrict a tabular representation of them in the present study to a few, limited disease groups.

7. While the above-mentioned parameters relate to measurements in the resting state, the pulmonary hemodynamics were studied also on mild exertion in many of the cases in the material, and the findings were considered to deserve brief consideration in the study.

8. Due to the complexity and the multi-faceted etiology of pulmonary hypertension, hardly any single catheterization material can contain a representative number of all possible varieties. Still, a single catheterization material may contain a fair number of cases of certain conditions where further documentation and evaluation of pulmonary hypertension be warranted, or in which the possible occurrence of pulmonary hypertension has been discussed in the literature and observations in the cases in the material may contribute decisively to this discussion. The same applies to interesting single cases within the material as well. The present inventory therefore included an evaluation of pulmonary hypertension in such unusual conditions and rare and interesting single cases represented in the material.

9. Since other aspects than pulmonary hypertension might be insufficiently elucidated in such cases, it was aimed at extending the study in these cases also to additional features warranting further evaluation.

10. To mention but a few examples, clinical, pathoanatomic, roentgenologic, electrocardiographic, phonocardiographic, and other investigative aspects of pulmonary hypertension are legion, and often complexly interwowen with those of an underlying disease. A complete study of such aspects goes far beyond the range of the present study. However, it was decided to give an account of them as they were met with in the group of pulmonary hypertension in which they may reasonably be present in a relatively isolated form, viz. in primary and chronic thromboembolic pulmonary hypertension.

11. A largely retrospective analysis of the effects of various medical treatment regimens applied in the patients in the material is hazardous, and was omitted. Instead, a new approach to the treatment of severe pulmonary hypertension of various etiology was sought. In particular, it was considered worth-while to study the possible beneficial effect of prolonged, ambulatory oxygen therapy in severe pulmonary hypertension.

12. Finally, while it was generally aimed at discussing the findings in the material in relation to the more important, pertinent literature, with some impact upon pioneering clinical and hemodynamic works and major recent studies and surveys, extensive reviewing was considered to be warranted of one particular sector of pulmonary hypertension, namely, the nosologic spectrum of primary and chronic pulmonary hypertension.

MATERIAL

During a 20-year period from the summer of 1948, when cardiac catheterization started at the Heart Laboratory of the Medical Clinic, Malmö General Hospital, to the autumn of 1968, 1288 patients were subjected to investigation with right heart catheterization, many of the cases twice or more, for diagnostic or control purposes on behalf of manifest or suspected cardio-pulmonary disease. In 111 of the patients, heart catheterization findings and other investigations revealed no overt cardio-pulmonary disorder, and these cases were excluded from the present study. In 17 cases, no pressure registrations from the right ventricle of from the pulmonary artery were obtained, and these cases were also excluded from the material, as were 55 cases of Fallot's tetralogy and 62 cases of pulmonic stenosis or other varieties of right cardiac dysfunction with right ventricular hypertension but largely normal pulmonary arterial pressure. An uniquely large catheterization series of carcinoid heart disease was included in the study, however, since the occurrence of pulmonary hypertension in this disorder has been much debated in the literature and observation in the present series was considered to shed light on this problem. The carcinoid heart disease cases are not represented in the tabular survey of the material, however. Table 1 shows the composition of the 1032 remaining patients in the material.

METHODS

a. Technical methods.

Although the technical equipment has changed during the 20-year period, basic conditions and techniques of the right heart catheterization have remained largely unaltered and have been thoroughly described for various intervals in the 20-year period in earlier works from the Heart Laboratory of the Medical Clinic in Malmö (Biörck et al., 1953; Hall, 1961; Johansson, 1966; XV). It can be briefly summarized, that the patients were studied in the recumbent position and that the zero level for the strain gauges during the investigations was the mid-thoracic line. The intravascular pressure recordings were obtained via a Cournand catheter and registrated by a standard electrocardiographic recorder. Mean pressures were obtained by electrical integration over a period including at least two respiratory cycles. Cardiac output was determined during the initial stages of the 20-year period by the Fick method; and during the later stages also by dye dilution technique.

b. Methods of study.

Heart catheterization records of all patients subjected to cardiac catheterization during the 20-year period were studied, and the hemodynamic data from every right heart catheterization collected and tabulated. Similarly, the other hospital records of these patients were studied, anamnestic and clinical data tabulated, and laboratory, electrocardiographic, phonocardiographic, roentgenologic, spirometric and other investigative data collected, analysed and tabulated. The systolic pulmonary arterial pressure (or, in a few cases where pulmonary arterial pressures were not obtained, the right ventricular systolic pressure) was utilized in order to group the cases into the different pulmonary arterial pressure levels. In re-catheterized cases, the data from the catheterization exhibiting the highest pulmonary arterial pressure were utilized in the tabular representation of the material, while the data from the other catheterizations were accounted for in the natural history study. The classification of cases into the various disease groups was according to the final clinical diagnosis.

All patients in the material were follow-up investigated at least until the autumn of 1971, regarding crude mortality and survival after the time of catheterization. The information was requested, repeatedly if necessary, from the parish records, and was obtained in a high proportion of the cases. 29 patients, most of whom were of foreign nationality or have emigrated, could not be traced, however.

Interesting cases of pulmonary hypertension within the material were personally re-examined, including in 30 of the cases, where permission was granted, re-catheterization.

Many of the findings thus obtained in the material investigation, are not included in the present study. It was tried to survey the basic patient data and the mortality and survival data in a tabular manner, while the hemodynamic findings were graphically illustrated. In the graphical representation, semi-computerized, linear and non-linear regression analyses according to the method of least square, and calculations of the significance levels were utilized (Cole, 1969). In the tabular representation, calculation of mean values and of standard deviation were according to routine statistic methods, as were t-test or chi-square estimations of significance levels (Remington & Schork, 1970).

FINDINGS

1. Represented disorders, and systolic pulmonary arterial pressure distribution in them.

Table 1 summarizes the major disease groups represented in the material, and the systolic pulmonary arterial pressure distribution within them. Increased pulmonary arterial pressures were found in 26/101 (26 %) of the cases in the atrial septal defect group, 32/78 (41 %) in the ventricular septal defect group, 24/85 (28 %) in persistent ductus arteriosus, 13/15 (87 %) in complex intracardiac shunt defects, 6/18 (33 %) in extracardiac shunt lesions, 13/13 (100 %) in primary and chronic thromboembolic pulmonary hypertension, 13/53 (25 %) in chronic obstructive pulmonary diseases, 8/46 (17 %) in pulmonary parenchymatous diseases, 4/5 (80 %) in lung fibrosis, 7/22 (32 %) in ventilatory disturbance, 192/263 (73 %) in mitral stenosis, 51/63 (81 %) in combined mitral stenosis and insufficiency, 11/20 (55 %) in mitral insufficiency, 14/29 (49 %) in heart constriction, 30/78 (38 %) in aortic valvular disease, 2/20 (10 %) in coarctation of the aorta; in the single case of Takayashu's disease, in 24/122 (20 %) of the cases in the left ventricular disease group, and, in all, in 471 of the 1032 cases (46 %) in the total material.

Corresponding figures regarding pronounced and severe pulmonary hypertension are: In atrial septal defect 7/101 (7 %), ventricular septal defect 22/78 (28 %), persistent ductus arteriosus 11/85 (13 %), complex intracardiac shunt defects 8/15 (53 %), extracardiac shunt lesions 3/18 (17 %), primary and chronic thromboembolic pulmonary hypertension 8/13 (62 %), chronic obstructive pulmonary diseases 0/53 (0 %), pulmonary parenchymatous diseases 0/46 (0 %), lung fibrosis 3/5 (60 %), ventilatory disturbance 0/22 (0 %), mitral stenosis 44/263 (17 %), combined mitral stenosis and insufficiency 10/63 (16 %), mitral insufficiency 2/20 (10 %), heart constriction 0/29 (0 %), aortic valvular disease 6/78 (8 %), coarctation of the aorta including the one case of Takayashu's disease 0/21 (0 %), left ventricular disease 2/122 (1.6 %), and total material, 126/1032 (12 %).

Put otherwise, the figures in table 1 implicate that the atrial septal defect group accounted for 101 of the 1032 cases in the total material (9.8 %) and for 26 of the 471 cases with elevated pulmonary arterial pressure (5.5 %), 7 of the 126 cases of pronounced and severe pulmonary hypertension (5.5 %) and 1 of the 69 (1.4 %) cases of severe pulmonary hypertension. Below are given corresponding figures for the other disorders in the material:

Ventricular septal defect	78 (7.6 %) -	32 (6.8 %) -	22 (17.5 %) -	18 (26.1 %)
Persistent ductus arteriosus	85 (8.2 %) -	24 (5.1 %) -	11 (8.7 %) -	9 (13.0 %)
Complex extracardiac shunt defects	15 (1.5 %) -	13 (2.8 %) -	8 (6.3 %) -	2 (2.9 %)
Extracardiac shunt lesions	18 (1.7 %) -	6 (1.3 %) -	3 (2.4 %) -	3 (4.3 %)
Primary and chronic thromboembolic pulmonary hypertension	13 (1.3 %) -	13 (2.8 %) -	8 (6.3 %) -	5 (7.2 %)

Chronic obstructive pulmonary diseases	53 (5.1 %) -	13 (2.8 %) -	0 (0 %) -	0 (0 %)
Pulmonary parenchymatous diseases	46 (4.5 %) -	8 (1.7 %) -	0 (0 %) -	0 (0 %)
Lung fibrosis	5 (0.5 %) -	4 (0.8 %) -	3 (2.4 %) -	2 (2.9 %)
Ventilatory disturbance	22 (2.1 %) -	7 (1.5 %) -	0 (0 %) -	0 (0 %)
Mitral stenosis	263 (25.5 %) -	192 (40.8 %) -	44 (34.9 %) -	21 (30.4 %)
Combined mitral stenosis and insufficiency	63 (6.1 %) -	51 (10.8 %) -	10 (7.9 %) -	4 (5.8 %)
Mitral insufficiency	20 (1.9 %) -	11 (2.3 %) -	2 (1.6 %) -	0 (0 %)
Heart constriction	29 (2.8 %) -	14 (3.0 %) -	0 (0 %) -	0 (0 %)
Aortic valvular disease	78 (7.6 %) -	30 (6.4 %) -	6 (4.8 %) -	2 (2.9 %)
Coarctation of the aorta	20 (1.9 %) -	2 (0.4 %) -	0 (0 %) -	0 (0 %)
Takayashu's disease	1 (0.1 %) -	1 (0.2 %) -	0 (0 %) -	0 (0 %)
Left ventricular diseases	122 (11.8 %) -	24 (5.1 %) -	2 (1.6 %) -	2 (2.9 %)

2. Age and sex of patients, duration of disease.

Table 1 also summarizes the age and sex distribution in the various disorders and pulmonary arterial pressure levels. Cases with congenital cardiac defects, for instance, shunt lesions and coarctation of the aorta, for natural reasons tended to be younger when appearing in the material than cases with acquired cardio-pulmonary diseases, in particular the chronic obstructive pulmonary disease cases and the cardiosclerosis cases. In most disease groups, however, the relative age distribution was similar in the different pulmonary arterial pressure levels. In linear regression analyses, significant relation between increasing age of the patients and elevation of the pulmonary arterial pressure was found only in the atrial septal defect ($p < 0.001$) and the extracardiac shunt lesion cases ($0.02 < p < 0.05$) (I, fig. 1), in chronic obstructive pulmonary disease ($p < 0.01$) (IV, fig. 1a), and in the adult cases of aortic valvular disease ($p < 0.1$) and the cardiosclerosis cases ($p < 0.01$) (VI, fig. 1).

Regarding the sex of the patients, there were more females than males in the atrial septal defect, persistent ductus arteriosus, mitral stenosis, combined mitral stenosis and insufficiency groups, slightly more females than males in the ventricular septal defect, extracardiac shunt lesion and primary and chronic thromboembolic pulmonary hypertension groups, while there were more males than females in the lung disorders, in mitral insufficiency, heart constriction and in disorders of the left ventricle. In the total material, there were only slightly more females than males (table 1). The relative sex distribution in the various pulmonary arterial pressure groups largely corresponded with that of the respective disorders.

The duration of disease naturally corresponds with the age of the patients in the congenital cardiac defect cases. In many of the acquired cardio-pulmonary disease groups it was hard to evaluate, but could be approximately assessed, from the time of first rheumatic affection in mitral valvular disease (V, fig. 2) and some of the cases of aortic valvular disease (VI), and from the time of symptomatological debute in the cardiosclerosis cases (VI). No significant relation between the duration of disease and the level of pulmonary arterial pressure was found in these groups.

3. Prognostic implications.

Table 2 summarizes the results in the follow-up investigation regarding cumulative mortality and survival after the time of catheterization in all cases in the material. 29 cases were lost for follow up. In the others, a significantly higher mortality was found among the cases with pulmonary hypertension as compared with the cases with the same disorder but normal pulmonary arterial pressure (table 2). This higher mortality was particularly apparent in the congenital shunt lesion cases and also in the total groups of lung disorders and left ventricular disorders. In the total disease groups (shunt lesions, lung disorders, mitral valvular disease + heart constriction, left ventricular disorders) the mortality - survival was statistically compared in each of the consecutive levels of pulmonary arterial pressure increase with the cases with normal pulmonary arterial pressure. By and large, a significantly higher mortality with higher levels of pulmonary hypertension was found (table 2). In a few groups, the results were uncertain on behalf of insufficient number of cases, however.

Results of performed operations were studied in the mitral valvular disease and heart constriction group (V, table 4), and briefly indicated also in the shunt lesion cases (I, fig. 2 and 3) and aortic valvular disease cases (VI). A higher operative and immediate postoperative mortality was found with increasing levels of pulmonary hypertension in all groups. On the other hand, there were a few cases in the congenital shunt lesion groups with pronounced and severe pulmonary hypertension who had successful result of performed operation (I, fig. 2 and 3), and in aortic valvular disease, the only cases with pulmonary hypertension who have survived, were those who underwent successful surgical correction (VI). Also in mitral valvular disease, the virtually sole cases with pronounced and severe pulmonary hypertension who have survived were those who underwent successful surgical correction (V, table 4). Only in the congenital cardiac shunt lesion group, particularly in ventricular septal defect, was there a sizeable fraction of cases with pronounced and severe pulmonary hypertension who have exhibited long-term survival, in a few cases for twenty years or more, without surgery (I, fig. 3). In the primary and chronic thromboembolic pulmonary hypertension group, there was also an increasing mortality with increasing levels of pulmonary hypertension (III). The group contained two cases with remarkably long survival, however. These two patients had moderate degree of pulmonary hypertension when first investigated (III, XIV).

4.-5. Natural history of pulmonary hypertension.

Re-catheterization findings in the various disease groups are also briefly described in the separate articles. "Survival graphs" of the congenital shunt lesion cases (I, fig. 2 and 3) include re-catheterization data as well. Most cases with normal pulmonary arterial pressure at the first catheterization showed largely stable values, while cases with moderate to pronounced pulmonary hypertension in the first catheterization - both intracardiac shunt defect and a few extracardiac shunt lesion cases - usually exhibited further increase of the pulmonary arterial pressure, and cases with severe pulmonary hypertension tended to have essentially unchanged pressure. However, cardiac surgery lowered the

pulmonary arterial pressure in a few, middle-aged patients with atrial septal defect and moderate pulmonary hypertension, and was successful also in a few cases of ventricular septal defect and persistent ductus arteriosus with moderate to pronounced degree of pulmonary hypertension (I, fig. 2 and 3). These cases usually had a large shunt volume with high pulmonary blood flow.

In the primary and chronic thromboembolic pulmonary hypertension group, six patients were re-catheterized. Concluding the clinical histories in all cases, and the re-catheterization findings, different patterns emerged (III). Rapid onset and progression was the most common course. However, in one case by diagnostical criteria belonging to the group of idiopathic pulmonary hypertension an unprecededly long disease duration was encountered (III, case 7). In another, similar case there was an unusually protracted course (III, case 3). In one case of pulmonary arterial aneurysm (III, case 9), the pulmonary hypertension, and in another (III, case 11), the clinical condition remained stable. In one case of suspected chronic thromboembolic pulmonary hypertension, slight improvement was noted after one year (III, case 14), and in one case of chronic thromboembolic pulmonary hypertension with only slightly elevated pulmonary arterial pressure at the first catheterization, regression took place (III, case 10).

In the lung disorder group, few re-catheterizations were performed. However, one case exhibited marked aggravation of the pulmonary hypertension parallelling deteriorating respiratory insufficiency, and two cases showed some improvement of the pulmonary arterial pressure when their respiratory state was also improved (IV).

Re-catheterization findings in 22 unoperated and 44 operated patients with mitral valvular disease - mitral stenosis in most of them - and in 11 operated cases of constrictive pericarditis are graphically represented (V, fig. 17-19). In the unoperated cases of mitral valvular disease a slight increase of the pulmonary arterial systolic pressure was usually found in the re-catheterization, which in the majority of the cases was performed 4-10 years after the first catheterization. Four cases showed significantly lower pressure at re-catheterization. In the operated mitral stenosis cases, re-catheterization was usually performed five years or more after the operation on behalf of suspected or manifest residual mitral stenosis and/or restenosis, and the pulmonary arterial systolic pressures were slightly lower than, equal to or exceeding the pre-operative pressure. A few cases were re-catheterized shortly after operation for control purposes, and showed satisfactory, short-term pulmonary hemodynamic results of the surgical treatment, while 5 of the cases of mitral stenosis developed post-operated mitral insufficiency with a rather rapid increase of the pulmonary arterial systolic pressure. Operation usually successfully lowered the pulmonary arterial pressure in the constrictive pericarditis cases. Since the pre- and postoperative hemodynamics in the latter cases have been previously reported (Malm, 1959 & 1963), they will not be further considered here. Similarly, a detailed account of the surgical results in the earlier part of the mitral valvular disease series has been previously given by others (Wulff et al., 1953; Biörck et al., 1955; Bülow et al., 1955)

A few re-catheterizations were performed in the aortic valvular disease cases, but were usually unrewarding. As judged by the clinical findings, the development of pulmonary hypertension was usually rapid in the aortic valvular disease cases, representing a near-terminal event in most of them (VI). The operative mortality was high in these cases, but in two of them, surgical correction was successful. Re-catheterizations were performed in a large number of the cardiosclerosis cases, before and after surgical treatment of angina pectoris. Since pre- and post-

operative hemodynamics in these cases have been reported by others (Malmborg et al., 1972), they are not repeated here. Largely, however, the resting pulmonary arterial pressures were unchanged.

6. Resting pulmonary hemodynamic patterns.

Apart from a comparison of the relation between the right atrial and the PCV pressure in mitral valvular disease and heart constriction (V, fig. 12-13), the hemodynamic studies were limited to pulmonary hemodynamic features. The relation between pulmonary blood flow and the pulmonary arterial pressure was studied in the congenital shunt lesion cases (I, fig. 10). No apparent correlation was found. Also in the lung-disorder group, most investigated cases had normal cardiac output (IV, fig. 6a). In the left ventricular disorder group, both the aortic valvular disease cases (VI, fig. 13a) and, in particular, the myocardial disease cases (VI, fig. 13b) exhibited an inversed relation between the cardiac output and the pulmonary artery pressure with a clustering of pulmonary hypertension among the cases with the lowest cardiac output.

The PVR index exhibited a satisfactory correlation with the pulmonary arterial pressure in the congenital shunt lesion cases, although extremely increased PVR index was uncommon (I, fig. 9). Elevated PVR index regularly signified the cases of primary and chronic thromboembolic pulmonary hypertension investigated in this respect (III). In lung disorders (IV, fig. 6c) and in mitral valvular disease (V, fig. 8-10) there was also an apparent correlation between the PVR index and the pulmonary artery pressure level, while in the heart constriction cases (V, fig. 11) and in the myocardial disease and aortic valvular disease cases (VI) elevated PVR index was exceptional. However, the PVR index is a composited hemodynamic variable, and might not precisely map out the relative proportions of pre- and postcapillary pulmonary vascular factors in pulmonary hypertension. The relation between pulmonary arterial pressures, in particular the pulmonary arterial diastolic pressure, and the PCV pressure may give a more sensitive illustration of these proportions. Since they may also be graphically represented and formularly evaluated in large materials, they were given particular attention in the present study. Summarizing here only the relation between the pulmonary arterial diastolic pressure and the PCV pressure in the various disorder groups, the following patterns were recorded:

In congenital shunt lesion cases, slight increase of the PCV pressure was not infrequent, predominantly in the cases with normal or slightly increased pulmonary arterial pressures (I, fig. 4-7). In the patients with pulmonary hypertension, PCV-left atrial pressures were usually normal or only slightly increased, with a marked pulmonary arterial diastolic pressure gradient against them (fig. 4-7, c). Linear regression analyses did not prove to be a useful tool in characterizing this gradient. Even if non-linear regression analyses in the whole material gave a somewhat better formular representation (I, fig. 8), it is apparent that in the higher levels of pulmonary hypertension, increased left atrial pressures, directly measured or reflected in the PCV pressures, tend to play no important part in the maintenance of increased pulmonary arterial diastolic pressures in shunt lesions, but that precapillary pulmonary vascular obstruction is the most significant mechanism encountered (I, fig. 8). A similar tendency was present in the few cases of primary and chronic thromboembolic pulmonary hypertension investigated in this respect (III, fig. 10). Also in the lung disorder group, some cases had upper normal or slightly increased PCV pressure at rest (V, fig. 4a-g), but particularly in the cases with pulmonary hypertension, a pulmonary arterial diastolic pressure gradient against the PCV pressure was a regular feature (IV, fig. 5).

In mitral valvular disease, all pulmonary arterial pressures showed a

close linear correlation to the PCV pressure up to a level of the latter of about 25 mm Hg, but with higher PCV pressure, the pulmonary arterial pressures tended to lie above the line of regression (V, fig. 3-5, a-c). The relation between the pulmonary arterial diastolic pressure and the PCV pressure was close to identity up to a level of both of around 25 mm Hg, but above that level there was a tendency to upward deviation of the pulmonary arterial diastolic pressure from the line of identity. This tendency might be discerned already in the linear regressions (V, fig. 3c, 4c, 5c), but non-linear regression analyses appeared to give a more accurate formular expression of this pattern (VI, fig. 7). Although there was a scatter of the observations, there appeared to be a continuous transition from a predominantly passive elevation of the pulmonary arterial diastolic pressure to a successively increasing contribution of precapillary pulmonary vascular obstruction, starting at a level of the pulmonary arterial diastolic-PCV pressures of about 25 mm Hg (V, fig. 7). In the heart constriction group, the pulmonary arterial diastolic pressure and the mean PCV pressure were close to identity within the entire pressure range encountered (V, fig. 6c), as was the case also in the myocardial disease group (VI, fig. 10); in non-linear regression analysis, too (VI, fig. 12b). In aortic valvular disease, however, there were a few cases with pulmonary hypertension and slight to moderate pulmonary arterial diastolic pressure gradient against the PCV pressure (VI, fig. 6a), and parabolic regression exhibited a slight tendency to upward deflection from the linear regression and the line of identity with higher levels of the PCV pressure (fig. 12a).

7. Exertional pulmonary hypertension.

Pulmonary arterial pressures were registrated on mild exercise in 40 of the lung disorder cases (IV, fig. 3), 10 of the heart constriction cases (V, fig. 14), 107 of the mitral valvular disease cases (the PCV pressure in 174 cases) (V, fig. 15), and 102 of the left ventricular disorder cases (VI, fig. 14). Particularly in the cases with increased pulmonary arterial pressure already at rest, but also in many of the cases with normal resting pulmonary arterial pressure, pronounced further elevation occurred. In the mitral valvular disease group, the magnitude of the pulmonary arterial mean pressure increase and the PCV pressure increase on exertion were compared in 91 cases in whom both were obtained (V, fig. 16). In regression analysis, a tendency to about similar magnitude of elevation was found (V, fig. 16). In the exercise studied left ventricular disorder cases, mainly cardiosclerosis patients, a close relation between the pulmonary arterial pressures and the PCV pressures, the latter equalling or exceeding the pulmonary arterial diastolic pressures, existed on exertion as it did in the resting state (VI, fig. 15), and significantly increased PVR index did not occur. The relation between the pulmonary flow increase and the pulmonary arterial mean pressure increase on exertion in normal individuals was compared with the findings in the cardiosclerosis cases. A markedly abnormal pattern emerged (VI, fig. 16). The largest pressure increases were actually encountered among the cases with the lowest flow increase (VI, fig. 16). The same tendency appeared also in absolute terms, as a slightly inversed relation between the pressure and flow recorded during exertion in the series (VI, fig. 17).

8. Pulmonary hypertension in some rare conditions and single cases represented in the material.

The material contains some interesting varieties of extracardiac shunt lesions, including four cases of pulmonary arteriovenous fistula, three of whom had normal pulmonary arterial pressure, but one had moderate pulmonary hypertension (table 1, I). Two sisters with Osler's disease had severe pulmonary hypertension, and were separately reported (VII). In one of them, a right-sided aortic arch, splenic artery aneurysms, small hepato-portal and extensive hepato-hepatic arteriovenous fistu-

la, and systemic-pulmonary arterial anastomose formation mainly from bronchial arteries were also demonstrated. In the other, intra-hepatic arteriovenous fistula appears possible in retrospect. Further, their family history is suggestive of similar manifestations of Osler's disease occurring in other members. Serial heart catheterizations were performed in the first patient, and demonstrated a successively increasing pulmonary hypertension and pulmonary vascular obstruction. It was concluded, that the pronounced systemic arteriovenous shunting offered the most plausible factor behind the pulmonary arterial pressure elevation, and that a parallell might be drawn with the mechanism of pulmonary hypertension in atrial septal defect (VII).

Three cases of the scimitar syndrome were also separately reported (VIII), and their hemodynamic features were compared with earlier heart catheterization data in the literature (VIII, table 1). It was concluded, that the extra load to the right heart through the anomalous pulmonary venous return, the pulmonary hypoplasia with consequent reduction of the pulmonary vascular bed, and the hypoplasia of the right pulmonary artery may all interact to develop pulmonary hypertension mainly by increasing the relative flow of blood through the unobstructed pulmonary arterial circuit. It seems unlikely from the obtained data that postcapillary congestion in the anomalously connecting pulmonary veins plays a role, other than exceptionally, in the development of pulmonary arterial pressure elevation in the scimitar syndrome.

The material includes an uniquely large heart catheterization series of the carcinoid heart disease. Pulmonary hypertension has been repeatedly claimed to be responsible for, possibly transitory, right cardiac failure in the carcinoid syndrome, but it has been stated that heart catheterization data so far are too sparse in the literature to allow a certain solution of this question (Chatterjee & Heather, 1968). The heart catheterization findings in the present series were considered to represent a decisive contribution to the evaluation of pulmonary hypertension in the disorder. Largely normal pulmonary arterial pressures were found in the series. It was concluded, that, on the whole, pulmonary hypertension does not contribute significantly to the development of right cardiac failure in carcinoid heart disease.

Interesting single cases in the material, which were separately reported with a review of the pertinent literature and, when possible, were follow-up studied, include a 74-year-old woman with enormous, successively increasing pulmonary arterial aneurysm but stable, moderate pulmonary hypertension (X); a case of malignant thymoma infiltrating into the pericardium and myocardium and compressing the left pulmonary artery and veins, and in whom several mechanisms of the moderate pulmonary hypertension encountered might have been operative (XI); a case of severe primary pulmonary hypertension in systemic sclerosis, in association with the report of which a retrospective autopsy material investigation documented the rather common occurrence of pulmonary vascular changes and right ventricular hypertrophy in this disorder (XII); a case of probably drug-induced pulmonary hypertension (XIII); and two cases of pulmonary hypertension of idiopathic type with uniquely long survival (XIV). It was also aimed at briefly describing some interesting cases in the material articles, including a case of central and peripheral pulmonary arterial aneurysms and aneurysmatic dilation of the thoracic aorta with moderate pulmonary hypertension (III, case 11), a few unusual cases of pulmonary fibrosis (IV), and a case of primary amyloidosis with marked cardiopulmonary involvement and severe pulmonary hypertension (VI).

9. Further evaluation of some rare disorders in the material.

Although it was not possible to trace all the relatives of the two sisters with Osler's disease and severe pulmonary hypertension,

the data obtained suggested that other members of the family may have had similar manifestations. These findings, and also data in the literature, were considered to indicate that there may be an intra-familial, true to type tendency of the manifestations of Osler's disease, or that Osler's disease may in fact be a heterogeneous syndrome (VII). One of the two sisters exhibited many features and findings not earlier described in the disorder, including some of the systemic arterial abnormalities recorded, and the corrosion cast preparation of the intra-hepatic vasculature with documentation both of hepato-portal and extensive hepato-hepatic arteriovenous anastomoses (VII).

In the report of the three scimitar syndrome cases, the opportunity was taken to briefly describe the embryology of the pulmonary arteries and veins, and also of reviewing the literature of related pulmonary malformations, such as pulmonary arterial agenesis and hypoplasia, unilateral anomalous pulmonary venous return and pulmonary parenchymatous agenesis and hypoplasia (VIII). Further, the pathogenesis of the scimitar syndrome was discussed, and it was concluded that the scimitar syndrome in many cases might be considered as basically a variety of hypoplasia or agenesis of the homo-lateral pulmonary artery (VIII).

The observations on the carcinoid heart disease series may also include some new general aspects of this disorder; such as the long-term outcome of the two cases in which a primary ovarian carcinoid could be successfully surgically removed but right valvular disease progressed; the myocardial biopsy findings in one of the cases, and the representation of the electrocardiographic and phonocardiographic findings in all cases (IX).

No re-investigation has earlier been reported in pulmonary arterial aneurysm. This is true for re-catheterization as well. Remarkable spirometric and electrocardiographic changes at the re-investigation in comparison with the first investigation was found in the case separately reported in the present study (X), and may contribute to the knowledge of the natural history of pulmonary arterial aneurysm.

10. Symptoms, signs and investigative findings.

These were evaluated in the group of pulmonary hypertension in which they may reasonably be present in relatively isolated form, viz. in primary and chronic thromboembolic pulmonary hypertension (III). In the present material, exertional dyspnea was the predominant symptom, to a varying degree present in all cases. Intermittent ankle oedema was not uncommon, while stationary oedema, dyspnea at rest and hepatomegaly occurred in the cases with the most pronounced pulmonary hypertension. Cyanosis was recorded in most cases, and was of peripheral type, usually not accompanied by finger-clubbing, and was observed to increase on exertion in some of the cases. Anginous chest pains were present in the cases with pronounced and severe degree of pulmonary hypertension, and were usually provoked by exercise. Syncopal attacks occurred in 5 of the 14 cases included in the material. Whitening and numbness of the peripheral extremities on cold exposure developed in three of the cases, while genuine Raynaud's syndrome was present in one. Other well-known, but unspecific, symptoms observed in some of the cases in the material include fatigue, feeling of reduced physical capacity, nervousness, cardiac palpitations and tachycardia. Three of the patients died suddenly, while three died in a picture of general circulatory failure, and two in a picture of predominant right ventricular failure.

Physical findings included presystolic jugular venous pulsations, right ventricular lift, accentuated and split second heart sound over the pulmonary area, systolic heart murmur along the left sternal border or over the apex, and low or low normal systolic blood pressure

but a relatively high diastolic blood pressure in many cases (I, table 1). In some of the cases with pronounced pulmonary hypertension in the series, a diastolic murmur with PM over the pulmonary area was noted.

The phonocardiograms may further illustrate the auscultatory findings (III, fig. 3). In the electrocardiograms (III, fig. 4), the QRS-T-angle (Fowler & Keith, 1968; Gahl et al., 1970) offered a rather satisfactory correlate to the level of the pulmonary arterial pressure increase (III, fig. 9a and b). Sinus rhythm was the rule and atrioventricular of bundle branch block was not common although an impression of incomplete right bundle branch block appeared in some of the cases (III, fig. 4). Signs of right ventricular hypertrophy were seen in most cases, while high and peaked P-waves were less common. Depression and inversion of the T waves over the right ventricular leads were usually seen. They regularly extended to the anterior precordial leads, but not commonly to the lateral precordial leads. Chest roentgenograms and angiocardiograms exhibited similar features, both in the cases with chronic thromboembolic pulmonary hypertension and in the cases with primary pulmonary hypertension. Slight to moderate right ventricular dilatation and hypertrophy, wide central pulmonary arteries, narrowing of peripheral pulmonary arteries predominantly from the third branching generation with scanty peripheral pulmonary vasculature, and, in the angiocardiograms, evidence of a slow contrast passage through the lungs, were commonly recorded radiologic findings in the series. The spirometric findings were usually characterized by normal or slightly reduced vital capacity, normal N_2-time, and, particularly in the cases with severe pulmonary hypertension, a tendency to low MVV_F and $FEV_{1.0}$, sometimes in association with increased FRC and RV and slightly increased or normal TCL. Signs of reduced oxygen diffusion in spite of hyperventilation, with low or low normal PaO_2 and $PaCO_2$ were also seen in many instances. On the whole, these abnormalities were not more pronounced in cases with known or suspected chronic thromboembolic pulmonary hypertension than in those with pulmonary hypertension of the primary type.

Routine laboratory analyses mainly demonstrated polyglobulia in some of the cases, and, in cases with advanced pulmonary hypertension, indications of liver stasis and slight, presumably prerenal uremia. Four cases with pronounced to severe pulmonary hypertension in whom serum LDH was determined exhibited a similar iso-enzyme pattern; elevation of the iso-enzyme fractions 1, 2 and 3, but not of the liver fraction, iso-enzyme 5.

Coagulation analyses revealed increased thrombocyte adhesivity in three cases, all of whom were of primary type. Two of these cases also had slightly increased fibrinolytic inhibitors. Three cases of verified or suspected chronic and thromboembolic pulmonary hypertension had pronounced, "thrombose-predisposing" abnormalities in the fibrinolytic system (III, table 7).

Exercise tests in 8 of the cases demonstrated reduced physical capacity, with fatigue, cyanosis and increase in pulse rate as well as in breathing frequency on low work load (III, table 5). Heart catheterization findings included right atrial "a-waves", no signs of hemodynamically significant tricuspid incompetence, and increased right ventricular end-diastolic pressure in many cases with pronounced pulmonary hypertension. The other heart catheterization findings have been briefly described in the previous sections.

The patho-anatomic findings in the series are also tabularly represented (III, table 8), and some examples of the macroscopic and microscopic lesions of primary and chronic thromboembolic pulmonary hypertension met with are shown in figures in the separate articles (III, fig. 5-8, XII, fig. 8-9, XIII, fig. 4-6).

11. Therapeutical studies.

Apart from brief indication of the operation results in some of the disorder groups in the material (I, V, VI), a retrospective evaluation of various treatment regimens applied in the cases in the material during the 20-year period was omitted. Instead, a new approach to the treatment of severe pulmonary hypertension of various origin was sought. To that end, the effect of long-term (4-7 weeks), continuous oxygen administration on the pulmonary arterial pressure was studied in four patients with pulmonary hypertension of varying etiology; three cases of shunt lesions, and one case of primary pulmonary hypertension (XV). None of these patients responded to chronic oxygen administration (2-10 l/min by nasal catheter) with a fall in the pulmonary arterial pressure, although there was a rise in PaO_2 in all cases. Neither was any fall in pulmonary pressure seen when these patients were allowed to breath pure oxygen for 10-25 minutes.

12. The literature of pulmonary hypertension.

The literature of pulmonary hypertension is very large. In the present study it was aimed at giving reference to some of the more important, early and recent works in connection with the separate articles. Much of this literature is not repeated in this summary. One particular sector of pulmonary hypertension, viz. the nosologic spectrum of primary and chronic thromboembolic pulmonary hypertension, was considered worthwhile to review more extensively (II), since the literature pertaining to this subject is now very complex, but dispersed, and since a similar, current bibliographic survey is virtually lacking. It was concluded, that both primary and chronic thromboembolic pulmonary hypertension are rare, yet complex disorders, sharing rather uniform clinical features and findings (II). There appears to exist a point in which primary and chronic thromboembolic pulmonary hypertension actually merge into each other, but from this point they seem to diverge into separate diseases (II). Although the field of primary and chronic thromboembolic pulmonary hypertension is thus at the moment extremely multi-faceted, some new data seem to indicate certain, general etiologic and patho-physiologic factors involved. It does not appear unlikely, therefore, that a more uniform knowledge of the disorders may soon be achieved.

1. Represented disorders, and systolic pulmonary arterial pressure distribution in them.

Although the disease and pulmonary arterial pressure frequencies summarized in table 1 are valid mainly for the present material, they may also have some bearing upon the occurrence of pulmonary hypertension in general.

The incidence figures of pulmonary hypertension in the ventricular septal defect, persistent ductus arteriosus and atrial septal defect cases in the material (I) are similar to those reported in some earlier, predominantly adolescent and adult materials (Evans & Short, 1958; Wood, 1958). In complex intracardiac shunt lesions of the type represented in the present material, direct transmission of the systolic pressure to the pulmonary arteries is of course often obligate (I). Also in extracardiac shunt lesions, it is well-known that pulmonary hypertension may sometimes occur (Holman, 1965; Childers et al., 1967; Sapru et al., 1969; I, VII, VIII). The incidence of primary and chronic thromboembolic pulmonary hypertension within the material largely corresponds with the range of 0.25 - 1 % of all cases subjected to right heart catheterization in some earlier reported, total catheterization materials (II; Storstein et al., 1966; Gurtner et al., 1968; Schwingshackl et al., 1969; v. Smekal et al., 1970; Voss & Harms, 1970). There are no earlier figures regarding the proportion of primary and chronic thromboembolic pulmonary hypertension among cases with increased pulmonary arterial pressure in total right heart catheterization materials, however, and it might be of interest, therefore, to note that this disorder group accounted for 2.8 % of the cases with elevated pulmonary arterial pressure, 6.3 % of the cases with severe and pronounced pulmonary hypertension, and 7.2 % of the cases with severe pulmonary hypertension in the present material. Only the ventricular septal defect, persistent ductus arteriosus and mitral valvular disease groups accounted for more cases of severe pulmonary hypertension. Among the lung disorder cases in the present material, pronounced and severe pulmonary hypertension occurred but in the pulmonary fibrosis group. It is well-known, that pulmonary fibrosis tends to be associated with the most pronounced pulmonary hypertension among disorders of the lung (Edwards, 1966). The other pulmonary disorder cases were usually catheterized during periods when they were in a relatively satisfactory and stable condition. In several similar materials, pulmonary arterial pressures have been found to be normal or only slightly increased in the majority of cases under such circumstances (see Bristow et al., 1966; IV). Mitral valvular disease constituted the largest group in the material as a whole, and also accounted for most cases of pulmonary hypertension. With a falling incidence of acute rheumatic fever (Sievers & Hall, 1971) this may not be the case in the future. However, earlier, comparable materials of mitral valvular disease give rather similar figures for pulmonary hypertension (Eliash, 1952; Wood, 1954). In heart constriction, it is well-known that the pulmonary arterial systolic pressure rarely exceeds 40 mm Hg at rest (Fowler, 1966). Also in aortic valvular disease, the findings of pulmonary hypertension in the present material correspond with earlier, sizeable hemodynamic studies (see Rotman et al., 1971; VI). The material includes an unusually large series of cardiosclerosis. Most of the cases were heart catheterized for preoperative evaluation on behalf of severe angina pectoris. Pronounced and severe pulmonary hypertension did not occur in this group, but slightly elevated pulmonary arterial systolic pressure and moderate pulmonary hypertension were recorded in 14 of them. The occurrence of pulmonary hypertension in myocardial diseases of many different types is well-documented in earlier, sizeable materials (see Storstein , 1967).

2. Age and sex of patients, duration of disease.

The fact that congenital cardiac defect cases were younger when appearing in the material than cases of acquired cardiopulmonary disorders seems self-evident. The same may be true for pulmonary hypertension as well, which occurred in the quite young age groups mainly in the congenital shunt defect cases, and in the old age groups mainly in the acquired cardio-pulmonary diseases in the material. In general, the absolute age distribution in the diseases represented in the material and of the pulmonary hypertension occurring in them thus reflect well-known features, and need not be further discussed here. The relative age distribution in the different pressure levels may be more interesting. With few exceptions, the age did not differ significantly between females and males included in the various disease and pressure groups (table 1). Significant differences were found only in a few of the congenital cardiac shunt lesion and lung disorder subgroups (table 1). In all essential, the following discussion of the relative age distribution would seem to apply to both sexes, therefore.

In atrial septal defect (Evans & Short, 1958; Wood, 1958; Cohn et al., 1967; Oakley & Goodwin,1967a; Herbert et al., 1969), and also in many varieties of extracardiac shunts (Holman, 1965; Kalke et al., 1967) there is usually a relation between the age of the patients and the occurrence of pulmonary hypertension, which was found also in the present material (I). However, these cases were still relatively young as compared with the few cases of pulmonary hypertension in chronic obstructive pulmonary disease (IV) and disorders of the left heart (VI). In the latter groups, there was also a correlation between the age of the patients and the pulmonary arterial pressure levels. In all other groups in the material, there was no significant such relation. For the large majority of cases in the material, age does not appear to have been a factor of importance for the development of pulmonary hypertension, therefore. In atrial septal defect and the cases with extracardiac shunt lesions, the development of pulmonary hypertension probably reflects long-term consequences of hemodynamic stresses rather than age per se (I; Wood, 1958), and also in chronic obstructive pulmonary disease and disorders of the left ventricle, it might be assumed that the trend towards increasing pulmonary arterial pressure levels with increasing age may reflect the advancement of the disease in the course of time more than sole consequences of the age, since ageing per se has not been shown to alter resting pulmonary arterial pressures significantly (Dexter et al., 1964; Granath & Strandell, 1964; Granath et al., 1964; Emirgil et al., 1967).

Also the absolute sex relations in the total disorder groups in the material broadly conform with well-known features of the respective disorders. Interestingly, similar sex relations as in the total disease groups persisted in their different pulmonary arterial pressure subgroups (table 1). A significantly increasing preponderance of females among cases with pronounced and severe degrees of pulmonary hypertension occasionally noted in congenital shunt lesions (Evans & Short, 1958; Espino-Vela et al., 1969) and mitral valvular disease (Wood, 1954) could not be verified in the present material.

Similarly, the duration of disease, which in congenital cardiac defects naturally corresponds with the age of the patients, did not prove to be an obvious correlate to pulmonary hypertension in the disorders in which it could be assessed with reasonable accuracy (V, VI). It may be assumed, then, that pulmonary hypertension might reflect the severity or the advancement of the disease condition more than factors like disease duration, age and sex of patients per se in the disorders represented in the material.

3. Prognostic implications.

As earlier mentioned, a close scrutiny of prognosis requires detailed representation of death causes, analysis of the results of applied treatment regimens, and comparison with other clinical parameters to the disease severity. However, the study was restricted to a comparison of the crude, cumulative mortality and survival from the time of catheterization as related to the pulmonary arterial pressure level recorded in this. A significantly higher mortality was found in the cases with pulmonary hypertension in comparison with the cases with normal pulmonary arterial pressures; both in the material as a whole, as in the various disease groups. In most of these, the age of the patients did not differ much between the pressure groups, and it would follow that age per se did not influence the different mortality significantly. Similarly, preliminary analysis did not indicate an obvious sex-difference in the cases who have survived as compared with the cases who have died, and, therefore, the mortality - survival results were summarized for both sexes. The influence of operation results upon the mortality - survival findings are but roughly indicated. None the less, evaluation of cumulative mortality and survival as related to the level of the pulmonary arterial pressure has not been performed earlier in a sizeable total right heart catheterization material, and the results seems to be of interest. It might be concluded, that groups of patients with the same disorder, during the same time, and with largely similar sex- and age distribution, but differing in terms of the level of the pulmonary arterial pressure, exhibited a significantly higher cumulative mortality with increasing levels of the latter. This was apparent in all disorders in which pulmonary hypertension was encountered in the material. It is true, that the material is retrospective, and that the present spectrum of pulmonary hypertension may probably have changed considerably due to factors like falling incidence of rheumatic fever (Sievers & Hall, 1971), earlier surgical intervention and more successful operation techniques in congenital cardiac shunt lesions (Overbeck, 1966; Reeve et al., 1966; Moulder et al., 1967; Hallidie-Smith, 1968; Laustela & Tala, 1968; Hallidie-Smith et al., 1969; Saksena et al., 1970), mitral valvular disease (Hamer et al., 1968; Kerth et al., 1971) and aortic valvular disease (Rotman et al., 1971). None the less, the findings may be of value not only as a source of reference for comparison with future materials, but as representing an established population of patients still to be met with from time to time. For similar reasons, brief indication of patterns in the natural history of pulmonary hypertension in the present material might be of general interest, too.

4-5. Natural history of pulmonary hypertension.

It may be concluded, that the re-catheterization observations in the atrial septal defect cases broadly accord with earlier findings (Evans & Short, 1958; Wood, 1958; Rudolph & Nadas, 1962; Cohn et al., 1967; Oakley & Goodwin, 1967a). There was a comparatively late, apparently gradual development of pulmonary hypertension, which was usually moderate to pronounced while severe pulmonary hypertension with inversed shunt was exceptional; and the surgical results were successful in cases with moderate degree of pulmonary hypertension, while the unoperated cases with pulmonary hypertension all expired (I, fig. 2). Although the number of observations is limited, similar tendencies might be discerned in the extracardiac shunt lesion cases as well (I, fig. 2).

The findings in the majority of patients with persistent ductus arteriosus and, in particular, with ventricular septal defect in the present material may probably be interpreted as relating to cases already having passed through the initial stages of the natural history of their pulmonary hypertension (Brotmacker & Campbell, 1958; Lucas et al., 1961; Lynfield et al., 1961; Rudolph & Nadas, 1962; Arcilla et al., 1963; Campbell, 1971). Extrapolation of probable preceeding events in the pa-

tients in the present material may however allow the following conclusions, pertaining to older children, adolescent and adult cases: (a) In cases where severe, pulmonary hypertension is established already during childhood, there has either been no initial, post-natal decrease at all of the pulmonary arterial pressure, or there has been a rapid relapse of pulmonary hypertension post-natally. In both situations, the rapid establishment of severe pulmonary hypertension would seem to indicate pronounced provoking factors, and would seem to bear a serious prognostic implication with short survival in most cases (I, fig. 3). (b) In patients where severe pulmonary hypertension is met with during adolescence or adulthood, there may have been a more protracted redevelopment of pulmonary hypertension, perhaps according to the re-catheterization observations in some of the cases. This might implicate less serious provoking factors, and a correspondingly better prognosis with longer survival; in a few of the cases of ventricular septal defect in the material amounting 20 years or even more after the first catheterization (I, fig. 3). In many of these cases, permission for re-catheterization was not granted, but the clinical findings in the follow-up investigations were consistent with stable pulmonary hypertension.

The primary and chronic thromboembolic pulmonary hypertension group is limited, but the rapidly progressive nature of the pulmonary hypertension in most cases conforms with earlier findings (Yu, 1958; Nielsen & Fabricius, 1961; Farrar, 1963; Goodwin et al., 1963; Wilhelmsen et al., 1963; Shane et al., 1964; Fowler et al., 1966; Storstein et al., 1966; Blount, 1967; Wagenvoort & Wagenvoort, 1970). However, it is also known that some cases may have a rather protracted cause (Nielsen & Fabricius, 1961; Charters & de C. Baker, 1970; Wagenvoort & Wagenvoort, 1970), although no longer survival in idiopathic pulmonary hypertension than 29 years has been reported earlier (Wagenvoort & Wagenvoort, 1970). The two cases in the present material with unusually long duration of idiopathic pulmonary hypertension (XIV) both had moderate degree of pulmonary hypertension when first investigated, while rapidly progressive cases usually had pronounced to severe pulmonary hypertension already in the first investigation (III). One case with a history suggesting recurrent pulmonary thromboembolism, exhibited regression of the slightly elevated pulmonary arterial pressure (III, case 10). It is well-known that lasting pulmonary hypertension may not develop in all cases of chronic pulmonary thromboembolism (Oakley & Goodwin, 1967b).

In lung disorders, it is recognized (Abraham et al., 1969; Kilcoyne et al., 1970) that there may be no constant distinctions between patient groups with pulmonary hypertension and without pulmonary hypertension. An individual patient with advanced pulmonary disease, during well-controlled phases of the disorder may often have largely normal pressures in the lesser circulation, but during periods of air-way-infection or other exacerbation may develop reversible cardiorespiratory failure with adjoining pulmonary hypertension (Kilcoyne et al., 1970). This may be illustrated by the re-catheterization observations in a few patients with pulmonary disease in the present series (IV).

The re-catheterization observations in the unoperated cases of mitral valvular disease may be compatible with a slow progression of the mitral valvular disease process in these patients (V). Four cases showed significantly lower pressures at the re-catheterization, however, which might reflect effects of medical treatment, since all of them were in incipient or manifest cardiac failure at the time of the first catheterization. In the operated cases of mitral valvular disease, it was not tried to distinguish between restenosis and residual mitral stenosis after commissurotomy (Harley, 1965; Higgs et al., 1970). However, the proportion of cases with unsatisfactory long-term results of commissurotomy appearing for re-catheterization largely corresponds

with the proportion of 10 % given in earlier materials (Harley, 1965).

Although re-catheterization for reasons given earlier are not represented in the left ventricular disease cases, the clinical impression of relatively rapid onset of pulmonary hypertension with serious prognostic implication (VI) deserves to be commented upon. There seems to exist an analogy with the well-known pattern of left ventricular failure, for instance, in aortic valvular disease, were a compensated state may be maintained for a long time until left ventricular failure with ominous, short-term prognostic implication rather rapidly occurs (Mitchell et al., 1954; Kirsh et al., 1970; Rotman et al., 1971). Thus, not only the level of the pulmonary hypertension, but also the underlying hemodynamic mechanisms might influence its prognostic significance and natural history features.

6. Resting pulmonary hemodynamic patterns.

In congenital shunt lesions, it has been repeatedly documented that the magnitude of the pulmonary blood flow, reflecting the shunt volume, tends to exhibit no good correlation to the degree of pulmonary hypertension (see Rudolph & Nadas, 1962). Most cases with pronounced and severe pulmonary hypertension in the present material had normal pulmonary blood flow (I, fig. 10), plausibly as a consequence of pulmonary vascular obstruction. However, there were also a few cases with pulmonary hypertension and high pulmonary blood flow (I, fig. 10). Although the PVR index correlated rather well with the pulmonary hypertension in the shunt lesion group, it was rarely very high (I, fig. 9). There seems to exist the possibility that high pulmonary blood flow may decrease its numerical value in some cases disproportionately to the magnitude of the pulmonary arterial diastolic pressure gradient against the PCV pressure, since the latter feature was obvious in all cases with moderate, pronounced and severe degree of pulmonary hypertension (I, fig. 8). Increased left atrial pressure has been discussed as a possible eliciting factor behind the development of pulmonary vascular obstruction in cardiac shunt defects (see Oakley & Goodwin, 1967a), but increased left atrial - PCV pressures were most apparent in cases with normal or slightly increased pulmonary arterial pressure in the present material. There was no evidence of a continuous transition between the two hemodynamic patterns, as was seen in the mitral valvular disease cases. Precapillary pulmonary vascular obstruction thus appeared to be the most important factor behind the maintenance of pulmonary hypertension in the shunt lesion cases in the present material. As mentioned earlier, this may not reflect the relations in infant cases, however.

In the primary and chronic thromboembolic pulmonary hypertension cases, pulmonary blood flow was commonly low, PCV pressures normal, and precapillary pulmonary vascular obstruction was reflected both in the PVR index and the relation between the pulmonary arterial diastolic pressure and the PCV pressure (III). All these features are well-known (Yu, 1958; Wilhelmsen et al., 1963; Storstein et al., 1966).

Similarly, although high output cardiac failure has been reported in lung disorders (Cournand, 1950; Harvey et al., 1951; Oakley & Goodwin, 1967b; Rao et al., 1968; Lockhart et al., 1969; Harvey et al., 1971), normal cardiac output failure appears to be more common in this disease group (Mounsey et al., 1952; Evans et al., 1963; Rao et al., 1968; Lockhart et al., 1969). As in the present series (IV), pulmonary hypertension is usually of obstructive type with an obvious pulmonary arterial diastolic pressure gradient against the PCV pressure (Harvey et al., 1971; IV, fig. 4c-g, fig. 5). Left ventricular failure has also been discussed, however, in various types of cor pulmonale (Altschule, 1962; Rao et al., 1968). A few cases in the present series had slight-

ly elevated PCV pressures, possibly indicating left ventricular dysfunction, but like in the congenital shunt lesion cases and primary and chronic thromboembolic pulmonary hypertension cases, pulmonary vascular obstruction appeared to be the most important mechanisms encountered in cases with significant degree of pulmonary arterial pressure elevation.

In the mitral valvular disease group, there was also a significant linear correlation between the PVR index and the pulmonary arterial pressure, but evaluation of the relation between the pulmonary arterial diastolic pressure and the PCV pressure showed a more complex pattern, differing from that of the above-mentioned disorder groups. The pulmonary arterial diastolic pressures and the PCV pressures were close to identity up to a level of both of around 25 mm Hg, but with higher pulmonary arterial diastolic and PCV pressures, most cases exhibited a diastolic pressure gradient against the latter, which could be expressed in terms of parabolic and exponential regression equations (V, fig. 7). The phenomenon of a diastolic pressure gradient against the PCV pressure occurring in higher levels of pulmonary hypertension in mitral valvular disease was early recognized (Dexter et al., 1950; Yu et al., 1954), but the deviation used to be arbitrarily diagraphed (Yu et al., 1954). Several factors have been held responsible for the development of pulmonary vascular obstruction in mitral valvular disease, like interstitial oedema (Jordan, 1965), active pulmonary vaso-constriction presumably due to local alveolar hypoxia (Wood, 1954; Jordan, 1965; Emanuel & Ross, 1967), and hyperplastic changes in the small, muscular pulmonary arteries (Harvey et al., 1971). The latter have long been known to occur in advanced stages of the disorder (Bülow et al., 1955; Edwards, 1966; Emanuel & Ross, 1967), but were early claimed to correspond badly with elevated pulmonary vascular resistance (Goodale et al., 1955). Observations that pulmonary arterial pressures may fall rapidly after injections of acetylcholine or hexamethonium, oxygen administration or successful valvulotomy even in cases with extreme resistance (see Hugenholtz et al., 1962) support that vaso-constriction may play at least an important, contributory part in the production of pulmonary vascular obstruction in mitral valvular disease. In conclusion, observations in the present material support that in mitral valvular disease, slight and moderate pulmonary hypertension can be ascribed predominantly to an elevation of the left atrial pressure, as in this pressure range rather accurately reflected in the PCV pressure (Harvey et al., 1971), but that in marked and severe pulmonary hypertension, which occurs mainly in mitral stenosis and in combined mitral stenosis and insufficiency, pulmonary vascular factors add to the passive transmission of the left atrial pressure to the pulmonary circulation (Wood, 1954; Emanuel & Ross, 1967).

The right atrial pressures are nearly always lower than the PCV pressures in mitral valvular disease (V, fig. 12) and when elevated, indicate right ventricular decompensation in most cases. In the heart constriction cases, the hemodynamic features were different. Corresponding with earlier findings (Malm, 1963; Fowler, 1966; Moscovitz, 1970; Shabetai et al., 1970), the systolic pulmonary arterial pressures rarely exceeded 40 mm Hg, the PCV pressures were considerably elevated and near identical throughout the entire pressure range encountered with the pulmonary arterial diastolic and, in pre-operative cases, also with the right atrial pressures (V, fig. 6c, 13a). Thus, the diastolic filling of both heart halves would seem to be restricted to an equal extent, and the systolic load the pulmonary circulation correspondingly diminished. This may explain why there appears no tendency to the development of a pulmonary arterial diastolic pressure gradient (V, fig. 6c) or significantly increased PVR index (V, fig. 11) with increasing degree of post-capillary pulmonary vascular congestion in heart constriction.

In the left ventricular disorder groups, finally, pulmonary hypertension was found in the cases exhibiting clinically manifest left ventricular failure, while signs of right ventricular decompensation were sparse (VI). The inversed relation between the pulmonary blood flow and the pulmonary arterial pressure (VI, fig. 13), in combination with normal PVR index in most cases may also be most consistent with the concept of left ventricular failure constituting the most important factor behind pulmonary hypertension in these disorders. This was further supported by the close identity between the pulmonary arterial diastolic pressure and the PCV pressure, evident throughout the entire pressure range encountered in all groups (VI, fig. 6, 10, 11). However, there were also cases, in particular in the aortic valvular disease group, with pulmonary hypertension and increased PCV pressure but with a slight to moderate pulmonary arterial diastolic pressure gradient against the PCV pressure (VI, fig. 6a, 12). The somewhat different findings in non-linear regression analysis in the myocardial disease cases (VI, fig. 12b) in comparison with the aortic valvular disease cases (VI, fig. 12a), may also reflect a slight tendency towards the development of a pulmonary arterial diastolic pressure gradient against the PCV pressure with higher levels of pulmonary hypertension in the latter group. In general, the appearance of this gradient "indicates that another factor, or factors, has been superimposed on the level of the left heart pressure" (Harvey et al., 1971). Concludingly, precapillary pulmonary vascular obstruction, might have contributed to pulmonary hypertension in a few cases of aortic valvular disease in the present material, but appears to be of relatively little importance in comparison with passive pressure transmission from a failing left heart. It must be noted that, in the absence of pulmonary vascular obstruction, the parameters relating to left ventricular failure which were studied here, i.e. the pulmonary arterial diastolic - PCV pressures, tend to equal simultaneous left atrial pressure (Jonsson & Sanai, 1969; Falicow & Resnekow, 1970) but may not precisely correspond with the direct measure of left ventricular failure, i.e., the left ventricular end-diastolic pressure. In normal individuals, this is virtually identical with the pulmonary arterial diastolic pressure (Kaltman et al., 1966; Falicow & Resnekow, 1970; Harvey et al., 1971), but in left ventricular failure it may often exceed the PCV-pulmonary arterial diastolic pressure (Falicow & Resnekow, 1970). However, such a difference would seem to increase rather than to diminish the expressiveness of elevated PCV - pulmonary arterial diastolic pressures as a correlate to left ventricular failure in cases without pulmonary venous obstruction of other cause. The mechanism of pulmonary vascular obstruction in aortic valvular disease might be reflex pulmonary vaso-constriction (Lloyd & Schneider, 1969) rather than hyperplastic pulmonary arterial changes (Harvey et al., 1971), since there is usually a rather rapid occurrence of left ventricular failure with adjoining pulmonary venous obstruction and pulmonary hypertension in the disorder (Kirsh et al., 1970; Rotman et al., 1971). The life expectancy from the onset of this stage is short, averaging 4 years (Mitchell et al., 1954). Thus, also the ominous prognostical implications of pulmonary hypertension in the left ventricular disorder cases in the material might relate mainly to the underlying left ventricular failure.

7. Exertional pulmonary hypertension.

Apart from in the aged (61-83 years) (Granath & Strandell, 1964; Granath et al., 1964), elevation of the systolic pulmonary arterial pressure over 40 mm Hg and of the mean pulmonary arterial pressure over 30 mm Hg on exertion are exceptional in the normal individual (Hellems et al., 1948; Barrat-Boyes & Wood, 1957; Sancetta et al., 1957; Sancetta & Kleinerman, 1957; Bevegård et al., 1960; Holmgren et al., 1960; Fishman et al., 1960; Denolin, 1961; Widimský et al., 1965), unless the work level is extremely high (Bevegård et al., 1963). The large majority of cases in whom exercise tests were performed in the present material were be-

low 65 years of age, and the work level was low. Exertional pulmonary hypertension, occurring at work levels similar to those required in many daily activites, might be equally important as resting pulmonary hypertension in many cases in the different diseases represented in the material. Some indication of the hemodynamic features of the exertional pulmonary arterial pressure elevation could be performed in the mitral valvular disease and the left ventricular disorder cases. In both, a passive pressure transmission appeared to be the most important factor; in myocardial diseases plausibly due to accentuated left ventricular dysfunction, and in mitral valvular disease presumably due to increased left atrial filling pressure (Gorlin et al., 1951; Eliasch, 1952; Wood, 1954; Emanuel & Ross, 1967). However, accentuated precapillary pulmonary vascular obstruction during exertion, perhaps secondary to hypoxia with vasospasm (Wood, 1954), might be of relevance in a proportion of the latter cases.

8-9. The rare conditions found in the material.

As mentioned earlier, hardly any single heart catheterization material can be expected to contain a representative number of all varieties of pulmonary hypertension. However, a single heart catheterization material may contain some rare and interesting cases, in which earlier documentation, both of pulmonary hypertension and of other features, is insufficient. Therefore, it was aimed not only at evaluating the pulmonary hypertension, but also other features of such disorders found in the material and considered to offer some new and interesting information.

Pulmonary hypertension has been recorded in two earlier cases of Osler's disease and interhepatic arteriovenous fistula (Ranniger & Ödman, 1963; Graham et al., 1964; Childers et al., 1967), but the familial occurrence of pulmonary hypertension within the disorder has not been earlier documented. Similarly, there have been no previous reports of corrosion cast preparation of the hepatic vasculature in similar cases, and many of the multiple, systemic arterial abnormalities recorded in one of the sisters also represent new data of the disorder. Interestingly, a study of the family history, and of the literature, supported that different types of internal vascular abnormalities in Osler's disease may tend to exhibit a true to type tendency within certain families. Thus, the conclusion was drawn, that there may either be an inter-familial variability of the internal organ involvement in Osler's disease, or may Osler's disease be a heterogeneous syndrome embracing different types of multiple angiomatoses with similar mucocutaneous manifestations and mode of genetical transmission (VII).

In the scimitar syndrome, previous evaluation of possible patho-physiologic mechanisms of pulmonary hypertension is scanty. It was considered worth-while to represent the heart catheterization findings in the literature in connection with the report of the three cases in the material (VIII, table 1). But in a few cases, post-capillary venous congestion due to the anomalous pulmonary venous return might have been a contributory factor to the development of elevated pulmonary arterial pressure. In the majority of the cases, it seems plausible that pulmonary hypertension in the scimitar syndrome offers analogies to that occasinally occurring in other extracardiac shunt lesions. Severe degree of pulmonary hypertension is uncommon, unless there is an associated cardiac shunt defect, which, however, is rather frequent in the scimitar syndrome (VIII). While clinical features of the scimitar syndrome have been extensively reviewed (Kiely et al., 1967; Mathey et al., 1969), the possible pathogenesis of the syndrome has been little analysed (Massumi et al., 1967; Maltz & Nadas, 1968; Rössler et al., 1968), and was therefore discussed at some length. It was concluded that isolated, infra-cardiac anomalous pulmonary venous return forms one type of the

syndrome and might be a rare member of the common type of anomalies in the pulmonary venous return that are related to defects in atrial septation. Other vascular and parenchymatous lesions in the same lung may, however, also be present in the scimitar syndrome. The possibility was discussed that this, "complex", type of the disorder might be considered as basically a variety of hypoplasia or agenesis of the homo-lateral pulmonary artery (VIII).

No more than three heart catheterized cases have been included in any earlier series of the carcinoid heart disease. Thus, the present material offered an opportunity of a relatively thorough evaluation of the problem of pulmonary hypertension in this disorder (Chatterjee & Heather, 1968). The normal pulmonary arterial pressures in the present series seem to be of interest, also in relation to the pulmonary veno-constrictive effect with consequent pulmonary venous hypertension recently ascribed to serotonin (Yoshitake, 1967; Daicoff et al., 1968). However, two cases of carcinoid heart disease with massive, chronic pulmonary thromboembolism have been described (Mc Kusick, 1956; Fowler et al., 1966), which may not purely be a chance event since there is evidence of a thrombocyte aggregation-enhancing effect of serotonin (Davis, 1968). In such cases, pulmonary hypertension is a likely occurrence (Fowler et al., 1966). Some other observations on carcinoid heart disease in the material, particularly the investigative findings and the observations on the natural history, were considered to be of interest, too, and would seem to offer new aspects of the disorder.

Pulmonary hypertension has been reported in a few earlier cases of "congenital idiopathic dilatation of the pulmonary artery" (Evans, 1951; Bulgarelli & Alzona, 1955; Turano & Gamaccini, 1958; Dreyfus & Morin, 1963) and in more pronounced aneurysmatic dilatation of the pulmonary arteries (Natelson et al., 1970). Re-catheterization observations in a similar case has not been reported earlier, however. In the case studied in the present material (X), the pulmonary hypertension remained largely stable over a period of ten years. Other features possibly pertaining to the natural history of the rare condition which the case represents, were (a) further, enormous dilatation of the central and both main pulmonary arteries, (b) development of a restrictive type of pulmonary parenchymatous dysfunction, and (c) change in the electrocardiographic pattern from signs of right ventricular hypertrophy and strain in 1961, to indications of biventricular hypertrophy and strain in 1971. These findings were considered worth-while to comment upon, since they constitute interesting, not previously documented features of the disease. The case of multiple, central and peripheral pulmonary aneurysms in combination with pronounced, aneurysmatic dilatation of the thoracic aorta, which is included in the primary and chronic thromboembolic pulmonary hypertension series (III, case 11), also represents a very unusual constellation. The case was discussed in relation to the pertinent literature in the separate article (III), and the discussion is not repeated here. However, similar pulmonary arterial abnormalities have been recorded earlier, but variously denominated ("tortuousity of the pulmonary arteries" (Beuren et al., 1969; Mac Donald et al., 1969), "weeping willow pattern" (Coelho et al., 1964), "multiple large branch stenoses" (Coelho et al., 1964; Singleton et al., 1964)). It might be generally concluded that the semasiology of peripheral pulmonary arterial malformations is still incomplete. Plausibly, there might be a wide variety of morphologic abnormalities in the pulmonary arteries, of aquired as well as of congenital nature, which remain to be typified, or alternatively, represent modalities of closely related or identical disease processes.

Another variety of central pulmonary artery lesion represented in the material, is compression of a pulmonary arterial branch by an external process (XI). Reviewing of the pertinent literature is given in the case

report. It was concluded that several mechanisms may be operative in the production of pulmonary arterial pressure elevation in similar cases (XI).

The heterogeneous nature of primary pulmonary hypertension is underlined in the review (II) and material (III) articles, and two interesting varieties are separately reported (XII) (XIII). Finally, two cases of idiopathic pulmonary hypertension of unusually long survival were reported with a brief discussion of the pertinent literature (XIV). It was concluded that the two cases may further substantiate earlier conclusions (Charters & de C. Baker, 1970), that rare cases clinically presenting as idiopathic pulmonary hypertension may exhibit a relatively stable and protracted course.

10. Symptoms, signs and investigative findings.

There are rather few sizeable materials of primary and chronic thromboembolic pulmonary hypertension reported in the literature (Wood, 1956; Goodwin et al., 1963; Wilhelmsen et al., 1963; Shane et al., 1964; Fowler et al., 1966; Storstein et al., 1966; Krähenbühl et al., 1968; Gurtner et al., 1968; Gahl et al., 1970), and additional documentation of the clinical findings may be warranted, therefore. The symptoms and signs in the present material correspond with earlier reported, and need not be further discussed here. Similarly, the investigative findings were discussed in the separate article (III), and examples of the roentgenologic changes have been given in the case reports (X, XII, XIII, XIV). Although specifically relating to the primary and chronic thromboembolic pulmonary hypertension series in the material, some of the findings, such as the auscultatory, phonocardiographic and electrocardiographic results, may plausibly have application to other varieties of pulmonary hypertension as well. Others, such as the roentgenologic, spirometric and laboratory data, may have interest predominantly in relation to possible application in the differential diagnosis between primary and chronic thromboembolic pulmonary hypertension (III). The findings in the coagulation analyses may be of particular interest since they revealed abnormalities regarded to be "thrombose-predisposing" both in cases of primary and chronic thomboembolic type. However, the most pronounced abnormalities were recorded in the latter cases, and further studies are needed in order to determine whether distinctive, quantitative or qualitative, pattern differences exist in detailed coagulation analysis between cases of primary pulmonary hypertension and cases of chronic thromboembolic pulmonary hypertension.

11. Prolonged ambulatory oxygen therapy in pulmonary hypertension of various etiology.

Encouraging reports have appeared recently on the beneficial effect of prolonged oxygen administration to patients with chronic air-way obstruction (Cotes & Gilson, 1956; Abraham et al., 1968; Petty & Finigan, 1968), and a number of studies has shown that the pulmonary hypertension of high altitude is reversible by descent to lower altitude (Penaloza et al., 1962; Grover et al., 1966). Since there is "a desperate need of a new treatment" (Storstein et al., 1966) of severe pulmonary hypertension of other varieties, it was thought worth-while studying the effect of prolonged oxygen administration to a limited number of such patients. The results were negative, however. It may be concluded that an effective treatment of severe, established pulmonary hypertension in similar cases still remains to be found (XV).

SUMMARY

An inventory of a 20-year right heart catheterization material from the Heart Laboratory of the Medical Clinic of Malmö General Hospital has been performed, some of the findings have been reported in separate articles, and are summarized in the present thesis.

1. The incidence of pulmonary hypertension and of consecutive levels of pulmonary hypertension in the various disease groups in the material was studied, and tabularly represented.

2. The absolute sex and age distribution of the patients in the different disease groups, and the relative sex and age distribution within the consecutive levels of pulmonary atrial pressure in the disorders, were evaluated. With few exceptions, sex and age per se did not seem to be significantly correlated to the degree of pulmonary hypertension. Similarly, the duration of disease could not be demonstrated to correlate with the level of the pulmonary arterial pressure.

3. The prognostic implication of pulmonary hypertension was indicated by comparing the crude mortality and survival from the time of catheterization in the cases with normal pulmonary arterial pressure and the cases with elevated pulmonary arterial pressure in the represented disorder groups. By and large, there was a significantly higher mortality in the cases with pulmonary hypertension. This finding is briefly discussed in relation to factors like age and sex of the patients, and results of performed operations.

4. Findings in re-catheterizations within the material were outlined in relation to patterns in the natural history of pulmonary hypertension.

5. Interesting cases in the material were personally re-investigated for the same purpose.

6. Resting pulmonary hemodynamic patterns relating to the pathophysiological type and mechanisms of the pulmonary hypertension developing in the various disorder groups in the material were analysed by graphical methods. Particular attention was paid to the relation between the pulmonary arterial diastolic pressure and the mean PCV pressure, which may be considered to give a graphically illustrative representation of the relative contribution of pulmonary vascular factors and of factors superimposed on this to the development and maintenance of pulmonary hypertension.

7. Occurrence and hemodynamical patterns of exertional pulmonary hypertension in some of the disorder groups in the material were briefly described.

8. The inventory of the heart catheterization material included a further documentation of some rare varieties of pulmonary hypertension, as well as an evaluation of the pulmonary hemodynamics in some unusual conditions, in which the development of pulmonary hypertension has been discussed in the literature.

9. The study of these cases was extended also to other features than pulmonary hypertension warranting further elucidation.

10. Symptoms, signs and investigative findings in pulmonary hypertension were studied in the disease group in which they may reasonably be present in relatively pure and isolated form, viz. in primary and chronic thromboembolic pulmonary hypertension.

11. Apart from indication of operation results in some of the disorder groups, a retrospective evaluation of treatment effects was omitted. Instead, a new approach to the treatment of severe pulmonary hypertension was sought. To that end, the effect of prolonged ambulatory oxygen therapy in pulmonary hypertension of various etiology was investigated.

12. The findings in the material investigation were discussed in relation to some of the more important, early and recent literature in the separate articles. In one particular sector of pulmonary hypertension, viz. the nosologic spectrum of primary and chronic thromboembolic pulmonary hypertension, more extensive reviewing was considered to be warranted.

ACKNOWLEDGEMENTS

First of all, I would like to express my most sincere gratitude to my chief, Professor Jan Waldenström, for guidance, generous help, and never-failing interest throughout the investigation. I am also deeply grateful to Associate Professor Bengt W. Johansson, for introducing me to the subject of pulmonary hypertension, for valuable suggestions and constructive criticism.

I also thank Professor Jan Waldenström and Associate Professor Bengt W. Johansson; and Professor Folke Linell, Associate Professor Jan Nordén, Dr. Clas Lindström and Dr. Alf Rausing of the Department of Pathology; Dr. Alf Torp of the Heart Laboratory; Dr. Jörgen Malmquist of the Medical Clinic; and Associate Professors Lars Andrén and Nils-Magnus Ohlson and Dr. Jan Ripa of the Department of Roentgenology, for associating me with, for actively contributing to and for co-operating in the separate studies. I extend my thanks to all colleagues at the Heart Laboratory, who have, during the years, performed the heart catheterizations, data from which I have utilized in the investigation.

I am most grateful to Professor Sven-Erik Lindell and his colleagues at the Department of Clinical Physiology for the same reasons, and for allowing me to utilize the investigative data obtained at their Department and for generously putting the technical and personal resources of their Department at my full disposal. The same thanks go to Professor Folke Linell and colleagues at the Department of Pathology; Professor Erik Boijsen and colleagues at the Department of Roentgenology; Associate Professor Arne Malm and colleagues at the Department of Thoracic Surgery, and Professor Carl-Gustav Bergstrand and colleagues at the Department of Pediatrics.

Throughout the study I have had the most excellent and energetic help, in all details of its accomplishment, by Miss Gunnel Rydell and Mrs. Maria Pleijel Nordenhök. I thank them heartily, also for the interest and never-failing loyalty they displayed.

I also acknowledge with thanks the invaluable statistical assistance and advice by Miss Barbro Eklund and Mrs. Siv Bornmyr; the expert drawings by Mr. Tage Bramstång and Mrs. Gunvor Nilsson; the skilful photographic work by Mr. John-Erik Fritzin, Mr. Rune Ohlsson, Miss Monika Svensson and Mr. Nils Sörbris; the excellent assistance in the heart catheterizations by Mrs. Inga-Maj Wennberg and her staff; the diligent and careful printing work by Mr. Stig Wadst, Mr. Robert Svensson and Mrs. Gunnel Andersson; and the experienced bibliographic advice by Mrs. Brita af Jochnick and Mrs. Brita Bernow.

Of the many others, which have offered their friendly and most valuable help, I wish to thank here also Mrs. Asta Ljungberg, Miss Inga-Lill Nilsson and their colleagues at the Heart Laboratory; Mrs. Oili Lindroos and colleagues at the Medical Archive; and Mr. György Gábor and Miss Karin Ekstrand and colleagues at the Department of Clinical Physiology.

This study was supported by the Swedish Association against Heart and Chest Diseases and the Hulda Almroth Foundation.

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Total material

Disorder group	Females (F) Number Nr	%	Age (years) Range	m	Sd	Males (M) Number Nr	%	Age Range	m	Sd	F+M Number Nr	%	Age Range	m	Sd
Shunt lesions															
Atrial septal defect	65	64	0.5–56	27.3	14.8	36	36	0.2–58	24.1	16.7	101	100	0.2 58	26.1	15.5
Ventricular septal defect	43	55	0.12–50	14.5	12.2	35	45	1–43	15.0	10.2	78	100	0.12–50	14.7	11.3
Persistent ductus arteriosus	67	79	0.67–53	17.0*	12.0	18	21	0.25 32	9.3*	7.5	85	100	0.25 53	15.4	11.6
1 + 2 + 3	175	66	0.12–56	20.2	14.2	89	34	0.2–58	17.5	14.0	264	100	0.12–58	19.3	*14.2
Others (unassociated with pulmonary stenosis)	6	40	0.02 20	6.3	7.7	9	60	0.05–8	2.5	3.3	15	100	0.02 20	4.0	5.6
1 + 2 + 3 + 4	181	65	0.02–56	19.7*	14.3	98	35	0.05–58	16.2*	14.1	279	100	0.02–58	18.5	14.3
5 Extra-cardiac shunts															
a) Systemic arteriovenous fistula	3	75	44–56	49.3	—	1	25	57	57.0	—	4	100	44–57	51.3	6.3
b) Pulmonary arteriovenous fistula	2	50	7–8	7.5	—	2	50	18 49	33.5	–	4	100	7–49	20.3	19.2
Anomalous pulmonary venous return	4	57	0.17–22	10.0	9.6	3	43	5–38	16.7		7	100	0.17 38	12.9	13.1
The scimitar syndrome	2	67	38 45	41.5	—	1	33	49	49.0	—	3	100	38–49	44.0	—
5 a + b + c + d	11	61	0.17–56	26.0	20.5	7	39	5–57	31.9	21.6	18	100	0.17 57	28.3	20.5
1 + 2 + 3 + 4 + 5	**192**	65	**0.02–56**	**20.1**	14.7	**105**	35	**0.05 58**	**17.2**	15.1	**297**	100	**0.02–58**	**19.1**	14.9
…ary and chronic thromboembolic pulmonary hypertension	**8**	62	**13–63**	**47.6**	16.7	**5**	38	**6–55**	**40.2**	19.9	**13**	100	**6–63**	**44.8**	17.6
…disorders															
…obstructive pulmonary disease	14	26	27–70	42.1**	12.3	39	74	20 70	53.3**	10.5	53	100	20–70	50.3	12.0
…onary parenchymatous diseases															
Cancer	0	—	—	—	—	16	100	25–70	57.4	10.7	16	100	25–70	57.4	10.7
Tuberculosis	6	32	21–60	42.7	14.5	13	68	22–62	42.6	13.5	19	100	21–62	42.6	13.4
Others	1	9	38	38.0	—	10	91	21–64	45.3	14.6	11	100	21–64	44.6	14.0
2 a + b + c	7	15	21–60	42.0	13.4	39	85	21–70	49.6	14.1	46	100	21 70	48.4	14.1
…onary fibrosis	2	40	6–71	38.5	—	3	60	30–47	39.7	—	5	100	6 71	39.2	23.8
…latory disturbance															
…excavatum	4	36	14–47	28.5	16.6	7	64	15–25	19.9	3.5	11	100	14–47	23.0	10.4
Pleural diseases	2	25	51–58	54.5	—	6	75	41–67	56.3	10.3	8	100	41–67	55.9	8.9
Obesity	1	33	29	29.0	—	2	67	55 56	55.5	—	3	100	29–56	46.7	—
4 a + b + c	7	32	14–58	36.0	17.4	15	68	15–67	39.2	19.8	22	100	14 67	38.2	18.7
1 + 2 + 3 + 4	**30**	24	**6–71**	**40.4****	15.7	**96**	76	**15 70**	**49.1****	14.5	**126**	100	**6–71**	**47.0**	15.2
…valvular disease and heart constriction															
…or predominant mitral stenosis	148	63	21–63	44.6	8.8	86	37	22–62	45.9	8.0	234	100	21 63	45.1	8.6
Operated mitral stenosis with restenosis or restenosis and insufficiency	23	79	25–66	46.5	9.4	6	21	29–63	44.3	13.2	29	100	25–66	46.1	10.1
1 a + b	171	65	21 66	44.9	8.9	92	35	22–63	45.8	8.3	263	100	21 -66	45.2	8.8
…ned mitral stenosis and insufficiency	47	75	21–61	45.1	8.4	16	25	28–55	41.3	9.5	63	100	21–61	44.1	8.7
…predominant mitral insufficiency	7	35	15–50	35.3	13.8	13	65	4–59	36.6	20.3	20	100	4 59	38.2	16.5
1 + 2 + 3	225	65	15 66	44.6	9.2	121	35	4–63	44.5	10.1	346	100	4–66	44.6	9.4
Constrictive pericarditis	6	25	30 62	41.7	11.8	18	75	7–67	42.8	14.7	24	100	7–67	42.5	13.8
Pericardial effusion or cyst	3	60	11–67	36.3	—	2	40	15–29	22.0	—	5	100	11 67	30.6	22.1
4 a + b	9	31	11 67	39.9	17.2	20	69	7 67	40.7	15.5	29	100	7–67	40.4	15.7
1 + 2 + 3 + 4	**234**	62	**11–67**	**44.5**	9.8	**141**	38	**4–67**	**44.0**	11.0	**375**	100	**4 67**	**44.3**	10.1
…rders of the left heart															
Aortic valvular disease															
Aortic stenosis	8	24	4–59	26.1	20.7	25	76	4–65	29.6	20.7	33	100	4–65	28.8	20.5
…mbined aortic stenosis and insufficiency	4	25	28–57	48.3	13.8	12	75	19–58	42.6	12.8	16	100	19–58	44.0	12.8
Aortic insufficiency	7	24	6 42	21.6	12.5	22	76	6 64	34.0	16.2	29	100	6–64	31.0	16.1
1 a + b + c	19	24	4 59	29.1	19.0	59	76	4–65	33.9	18.1	78	100	4 65	32.7	18.3
…ation of the aorta	6	30	2–42	15.7	15.3	14	70	4–70	20.9	18.7	20	100	2–70	19.4	17.5
…ashu's disease	1	100	17	17.0	—	0	—	—	–	—	1	100	17	17.0	—
1 + 2 + 3	26	26	2–59	25.5	18.5	73	74	4 -70	31.4	18.8	99	100	2 70	29.9	18.8
…roelastosis cordis + aortic hypoplasia	0	—	—	—		1	100	0.08	0.08		1	100	0.08	0.08	–
…ardial diseases other than cardiosclerosis	7	28	41 71	55.0	9.8	18	72	0.5–74	37.6	24.5	25	100	0.5 -74	42.4	22.7
…osclerosis	7	7	45–67	54.3	7.5	89	93	34 72	54.7	7.5	96	100	34 72	54.7	7.5
4 a + b + c	14	11	41–71	54.6	8.4	108	89	0.08–74	51.4	14.5	122	100	0.08 74	51.7	13.9
1 + 2 + 3 + 4	**40**	18	**2–71**	**35.7***	21.0	**181**	82	**0.08–74**	**43.3***	19.0	**221**	100	**0.08 -74**	**41.9**	19.6
Total sum	**504**	**49**	**0.02–71**	**34.3**		**528**	**51**	**0.05–74**	**39.3**		**1032**	**100**	**0.02–74**	**36.9**	

Normal systolic pulmonary arterial pressure (≤30 mm Hg)

Disorder group	Females Number Nr	%	Age Range	m	Sd	Males Number Nr	%	Age Range	m	Sd	F+M Number Nr	%	Age Range	m	Sd	p
Atrial septal defect	49	65	0.5 -54	24.0	13.3	26	35	3–58	24.	15.2	75	100	0.5 -58	24.1	13.9	0.8 > p > 0.7
Ventricular septal defect	28	61	0.12–50	13.6	10.6	18	39	1–43	15.	11.2	46	100	0.12 -50	14.2	10.7	0.3 > p > 0.2
Persistent ductus arteriosus	49	80	0.67–53	14.8	10.8	12	20	5–19	10	4.6	61	100	0.67 -53	13.9	10.1	0.6 > p > 0.5
1 + 2 + 3	126	69	0.12 54	18.1	12.6	56	31	1 -58	18	13.5	182	100	0.12–58	18.2	12.9	0.2 > p > 0.1
Others (unassociated with pulmonary stenosis)	1	50	7	7.0	—	1	50	0.17	0. 7		2	100	0.17 7	3.6	—	0.8 > p > 0.7
1 + 2 + 3 + 4	127	69	0.12–54	18.0	12.6	57	31	0.17–58	18.	13.6	184	100	0.12 -58	18.0	12.9	0.05 > p > 0.01
5 Extra-cardiac shunts																
a) Systemic arteriovenous fistula	1	50	56	56.0	—	1	50	57	57.0	—	2	100	56–57	56.5	—	0.3 > p > 0.2
b) Pulmonary arteriovenous fistula	2	67	7–8	7.5	.	1	33	18	18.	-	3	100	7–18	11.0		0.3 > p > 0.2
Anomalous pulmonary venous return	4	57	0.17 22	10.0	9.6	3	43	5 -38	16.	18.5	7	100	0.17–38	12.9	13.1	—
The scimitar syndrome	0	—		-	—	0		—	-	—	0	—	—	—	-	.
5 a + b + c + d	7	58	0.17 56	15.9	19.0	5	42	5 -57	25.	22.2	12	100	0.17–57	19.7	19.9	0.8 > p > 0.7
1 + 2 + 3 + 4 + 5	**134**	68	**0.12–56**	**17.9**	12.9	**62**	32	**0.17 58**	18	14.4	**196**	100	**0.12 58**	**18.1**	13.4	0.1 > p > 0.05
…ary and chronic thromboembolic pulmonary hypertension	**0**	—	—		—	**0**	-	-	-	—	**0**	.	-	.		—
…obstructive pulmonary disease	10	25	27 70	41.1*	13.1	30	75	20 70	51 *	11.1	40	100	20–70	49.0	12.3	0.7 > p > 0.6
Cancer	0	—	—	—	—	10	100	25–70	55	12.2	10	100	25–70	55.0	12.2	—
Tuberculosis	5	29	21 60	42.6	16.2	12	71	22–62	40	12.6	17	100	21–62	41.4	13.3	0.6 > p > 0.5
Others	1	9	38	38.0	-	10	91	21 64	45	14.6	11	100	21 64	44.6	14.0	
2 a + b + c	6	16	21 60	41.8	14.3	32	84	21 70	46	14.1	38	100	21–70	46.0	14.1	p > 0.8
…onary fibrosis	1	100	6	6.0	–	0	—	—		—	1	100	6	6.0	-	0.2 > p > 0.1
…excavatum	4	40	14–47	28.5	16.6	6	60	15–25	19.	3.7	10	100	14–47	23.1	11.0	0.5 > p > 0.4
Pleural diseases	0		–			4	100	41–66	52	10.8	4	100	41 66	52.8	10.8	0.2 > p > 0.1
Obesity	1	100	29	29.0	—	0	—		—	—	1	100	29	29.0	—	0.1 > p > 0.05
4 a + b + c	5	33	14 47	28.6	14.4	10	67	15 66	32	18.5	15	100	14 -66	31.4	16.8	p > 0.8
1 + 2 + 3 + 4	**22**	23	**6 -70**	**36.9****	15.5	**72**	77	**15 70**	**46** **	14.7	**94**	100	**6 70**	**44.5**	15.4	p > 0.8
…or predominant mitral stenosis	41	58	28 59	43.8	9.3	30	42	32–55	45	6.6	71	100	28–59	44.5	8.3	0.3 > p > 0.2
Operated mitral stenosis with restenosis or restenosis and insufficiency	0	—	—	—	—	0				.	0				–	
1 a + b	41	58	28 - 59	43.8	9.3	30	42	32–55	45.	6.6	71	100	28–59	44.5	8.3	0.2 > p > 0.1
…ned mitral stenosis and insufficiency	8	67	21 61	43.0	12.7	4	33	28 - 51	39	11.7	12	100	21 61	41.7	12.0	0.5 > p > 0.4
…predominant mitral insufficiency	5	56	15–50	35.0	14.2	4	44	4–59	40	24.8	9	100	4–59	37.4	18.4	0.1 > p > 0.05
1 + 2 + 3	54	59	15 61	42.8	10.4	38	41	4 59	44.	12.3	92	100	4 61	43.5	10.2	0.2 > p > 0.1
Constrictive pericarditis	0	-	—	—	—	10	100	36 67	49.	10.2	10	100	36–67	49.1	10.2	0.05 > p > 0.01
Pericardial effusion or cyst	3	60	11 67	36.3	-	2	40	15 -29	22	—	5	100	11 -67	30.6	22.1	—
4 a + b	3	20	11 67	36.3		12	80	15–67	44	14.3	15	100	11 -67	42.9	17.0	0.2 > p > 0.1
1 + 2 + 3 + 4	**57**	53	**11 -67**	**42.5**	11.5	**50**	47	**4–67**	**44.**	11.0	**107**	100	**4–67**	**43.4**	11.3	0.05 > p > 0.01
Aortic stenosis	7	33	4–50	21.4	17.5	14	67	5–61	26.	18.7	21	100	4–61	24.9	18.1	0.2 > p > 0.1
…mbined aortic stenosis and insufficiency	1	20	57	57.0	-	4	80	19–50	31.	15.1	5	100	19–57	36.4	17.4	0.8 > p > 0.7
Aortic insufficiency	5	23	9–32	20.6	—	17	77	6 59	30.	16.2	22	100	6–59	28.5	15.3	0.8 > p > 0.7
1 a + b + c	13	27	4 57	23.8	16.6	35	73	5–61	29.	16.8	48	100	4 -61	27.8	16.8	0.5 > p > 0.4
…ation of the aorta	5	28	2–42	17.4	16.4	13	72	4–70	22	18.8	18	100	2 70	20.9	17.8	0.6 > p > 0.5
…ashu's disease	0	—	—	—	—	0				-	.			-	.	
1 + 2 + 3	18	27	2–57	22.1	16.3	48	73	4 70	27.	17.5	66	100	2 70	25.9	17.2	0.8 > p > 0.7
…roelastosis cordis + aortic hypoplasia	0	—	-			0	—			—	0		-	-	-	—
…ardial diseases other than cardiosclerosis	6	38	41 71	55.8	10.5	10	62	0.5 64	34.	23.1	16	100	0.5–71	42.7	21.6	0.2 > p > 0.1
…osclerosis	7	9	45–67	54.3	7.5	75	91	34–69	51.	7.1	82	100	34–69	54.5	7.1	0.3 > p > 0.2
4 a + b + c	13	13	41–71	55.0	8.7	85	87	0.5–69	52.	11.9	98	100	0.5- 71	52.5	11.5	0.3 > p > 0.2
1 + 2 + 3 + 4	**31**	19	**2–71**	**35.9**	21.3	**133**	81	**0.5–70**	**42.**	22.4	**164**	100	**0.5–71**	**41.8**	19.2	0.6 > p > 0.5
Total sum	**244**	**43**	**0.12–71**	**27.6**		**317**	**57**	**0.17–70**	**39.0**		**561**	**100**	**0.12 71**	**34.3**		

Sum Pulmonary hypertension (≥31 mm Hg)

Disorder group	Females Number Nr	%	Age Range	m	Sd	Males Number Nr	%	Age Range	m	Sd	F+M Number Nr	%	Age Range	m	Sd
Atrial septal defect	16	62	7 -56	37.3	15.1	10	38	0.2 - 50	23.8	20.9	26	100	0.2–56	32.1	18.4
Ventricular septal defect	15	47	0.17–50	16.3	15.1	17	53	2 37	14.8	9.3	32	100	0.17 50	15.5	12.2
Persistent ductus arteriosus	18	75	0.75 -52	23.0*	13.6	6	25	0.25–32	8.0*	12.0	24	100	0.25 52	19.2	14.5
1 + 2 + 3	49	60	0.17–56	25.6**	16.7	33	40	0.2 50	15.1**	13.7	82	100	0.17 56	21.9	16.5
Others (unassociated with pulmonary stenosis)	5	38	0.02 -20	6.1	8.6	8	62	0.05–8	2.8	3.4	13	100	0.02–20	4.1	5.9
1 + 2 + 3 + 4	54	57	0.02–56	23.8**	17.0	41	43	0.05–50	13.6**	14.4	95	100	0.02–56	19.1	16.4
a) Systemic arteriovenous fistula	2	100	44–48	46.0	—	0	—	—	—	—	2	100	44–48	46.0	—
b) Pulmonary arteriovenous fistula	0	—				1	100	49	49.0	—	1	100	49	49.0	—
Anomalous pulmonary venous return	0		—	—	.	0	—	—			0		—	—	—
The scimitar syndrome	2	67	38 45	41.5	.	1	33	49	49.0		3	100	38 49	44.0	-
5 a + b + c + d	4	67	38 -48	43.8	4.2	2	33	49	49.0	-	6	100	38–49	45.5	4.2
1 + 2 + 3 + 4 + 5	**58**	57	**0.02–56**	**25.2****	17.2	**43**	43	**0.05 50**	**15.3****	16.0	**101**	100	**0.02–56**	**21.0**	17.3
…ary and chronic thromboembolic pulmonary hypertension	**8**	62	**13–63**	**47.6**	16.7	5	38	**6–55**	**40.2**	19.9	**13**	100	**6–63**	**44.8**	17.6
…obstructive pulmonary disease	4	31	29–55	44.8**	11.1	9	69	52–69	59.3**	5.7	13	100	29–69	54.5	9.9
Cancer	0	—	—	—	—	6	100	49–68	61.5	6.7	6	100	49–68	61.5	6.7
Tuberculosis	1	50	43	43.0		1	50	62	62.0		2	100	43–62	52.5	—
Others	0			—	–	0		–	.	—	0	—	—		—
2 a + b + c	1	13	43	43.0	—	7	87	49 68	61.6	5.1	8	100	43 68	59.3	8.7
…onary fibrosis	1	25	71	71.0	-	3	75	30–47	39.7	—	4	100	30 71	47.5	17.2
…excavatum	0	—	—	—	—	1	100	22	22.0	—	1	100	22	22.0	—
Pleural diseases	2	50	51 58	54.5	—	2	50	60–67	63.5	—	4	100	51–67	59.0	6.6
Obesity	0		-	-		2	100	55–56	55.5	—	2	100	55 -56	55.5	—
4 a + b + c	2	29	51 58	54.5	—	5	71	22 67	52.0	17.4	7	100	22 67	52.7	14.4
1 + 2 + 3 + 4	8	25	**29–71**	**50.3**	12.2	**24**	75	**22–69**	**55.8**	11.5	**32**	100	**22 71**	**54.4**	11.7
…or predominant mitral stenosis	107	66	21 -63	44.7	10.8	56	34	22 62	45.4	10.1	163	100	21 63	45.3	9.0
Operated mitral stenosis with restenosis or restenosis and insufficiency	23	79	25 -66	46.5	9.4	6	21	29 63	44.3	13.2	29	100	25 66	46.1	10.1
1 a + b	130	68	21 66	45.3	8.8	62	32	22 -63	45.8	9.1	192	100	21 66	45.4	8.9
…ned mitral stenosis and insufficiency	39	76	30–61	45.6	7.4	12	24	28–55	42.0	9.1	51	100	28 61	44.7	8.1
…predominant mitral insufficiency	2	18	23 49	36.0	–	9	82	8 56	44.7	12.0	11	100	8–56	38.7	15.7
1 + 2 + 3	171	67	21–66	45.2	9.1	83	33	8 63	44.6	9.9	251	100	8–66	44.8	9.5
Constrictive pericarditis	6	43	30–62	41.7	11.8	8	57	7–54	34.9	16.2	14	100	7–62	37.8	14.4
Pericardial effusion or cyst	0				-	0	–			—	0	—	—		.
4 a + b	6	43	30 -62	41.7	11.8	8	57	7 -54	34.9	16.2	14	100	7 62	37.8	14.4
1 + 2 + 3 + 4	**177**	66	**21–66**	**45.1**	8.7	**91**	34	**7–63**	**43.7**	11.1	**268**	100	**7–66**	**44.6**	9.6
Aortic stenosis	1	8	59	59.0	—	11	92	4–65	33.5	23.2	12	100	4–65	35.7	23.3
…mbined aortic stenosis and insufficiency	3	27	28 -57	45.3	—	8	73	40–58	48.3	6.9	11	100	28–58	47.5	9.1
Aortic insufficiency	2	29	6 -42	24.0	—	5	71	30- 64	44.1	12.3	7	100	6 64	38.6	17.5
1 a + b + c	6	20	6 59	40.5	20.4	24	80	4–65	40.7	18.0	30	100	4 65	40.7	18.1
…ation of the aorta	1	50	7	7.0		1	50	4	4.0		2	100	4 7	5.5	2.1
…ashu's disease	1	100	17	17.0	.	0	.	–	—		1	100	17	17.0	-
1 + 2 + 3	8	24	6–59	33.4	21.9	25	76	4–65	39.2	19.1	33	100	4–65	37.8	19.6
…roelastosis cordis + aortic hypoplasia	0	—	—	—	—	1	100	0.08	0.08	–	1	100	0.08	0.08	–
…ardial diseases other than cardiosclerosis	1	11	50	50.0	—	8	89	0.5–74	41.0	27.5	9	100	0.5 -74	42.0	25.9
…osclerosis	0	—	—	—	—	14	100	41 72	56.1	9.8	14	100	41 -72	56.1	9.8
4 a + b + c	1	4	50	50.0	—	23	96	0.08–74	48.4	21.5	24	100	0.08 74	48.5	21.1
1 + 2 + 3 + 4	**9**	16	**6 59**	**35.2**	21.2	**48**	84	**0.08 74**	**43.6**	20.6	**57**	100	**0.08–74**	**42.3**	20.7
Total sum	**260**	**55**	**0.02–71**	**40.6**		**211**	**45**	**0.05–74**	**39.2**		**471**	**100**	**0.02 -74**	**39.9**	

Slightly elevated systolic pulmonary arterial pressure (31–40 mm

Disorder group	Females Number Nr	%	Age Range	m	Sd	Males Number Nr	%	Age Range	m	Sd	F+M Number Nr	%	Age Range	m
Atrial septal defect	7	58	7–53	28.6	17.0	5	42	0.2–44	14.0	18.5	12	100	0.2–53	22.5
Ventricular septal defect	1	20	7	7.0		4	80	9–37	17.0	13.4	5	100	7–37	15.0
Persistent ductus arteriosus	7	78	0.75–39	19.5	12.6	2	22	0.25–5	2.6	—	9	100	0.25 39	15.8
1 + 2 + 3	15	58	0.75–53	22.9	15.2	11	42	0.2–44	13.0	14.8	26	100	0.2–53	18.7
Others (unassociated with pulmonary stenosis)	0	—	—	.	—	1	100	8	8.0	—	1	100	8	8.0
1 + 2 + 3 + 4	15	56	0.75 -53	22.9	15.2	12	44	0.2–44	12.6	14.2	27	100	0.2–53	[illegible]
a) Systemic arteriovenous fistula	0	—	—	—	—	0	—	—	—	—	0	—	—	—
b) Pulmonary arteriovenous fistula	0	—	—	–	-	0	—	.	—	—	0	—	—	—
Anomalous pulmonary venous return	0		—	—	-	0	—	.	—	—	0	—		
The scimitar syndrome	1	50	38	38.0	—	1	50	49	49.0	.	2	100	38 49	[illegible]
5 a + b + c + d	1	50	38	38.0	—	1	50	49	49.0		2	100	38 -49	[illegible]
1 + 2 + 3 + 4 + 5	**16**	55	**0.75 53**	**23.9**	15.2	**13**	45	**0.2–49**	**15.4**	16.9	**29**	100	**0.2 53**	20.
					0.20 > p > 0.10									
…ary and chronic thromboembolic pulmonary hypertension	**1**	100	**54**	**54.0**	—	**0**	—	—	—	—	**1**	100	**54**	54.0
…obstructive pulmonary disease	4	44	29–55	44.8*	11.1	5	56	53–69	58.8*	6.5	9	100	29–69	[illegible]
Cancer	0	—	—	—	—	4	100	60–68	64.3	3.5	4	100	60–68	64.3
Tuberculosis	1	50	43	43.0	—	1	50	62	62.0	—	2	100	43–62	52.5
Others	0		—	—	—	0	—	—	—	—	0		—	
2 a + b + c	1	17	43	43.0	—	5	83	60–68	63.4	2.6	6	100	43 -68	60.3
…onary fibrosis	0		—		–	0			—		0	—	—	
…excavatum	0	—	—	—	—	0	—	—	—	—	0	—	—	—
Pleural diseases	2	50	51–58	54.5	—	2	50	60–67	63.5	—	4	100	51–67	59.0
Obesity	0	—	—	—	—	1	100	56	56.0	—	1	100	56	56.0
4 a + b + c	2	40	51–58	54.5	4.9	3	60	56 67	61.0	.	5	100	51 67	58.4
1 + 2 + 3 + 4	**7**	35	**29–58**	**47.3*****	9.5	**13**	65	**53–69**	**61.2*****	5.3	**20**	100	**29–69**	**56.4**
					0.30 > p > 0.20									
…or predominant mitral stenosis	41	64	26–58	45.6	10.1	23	36	32–57	44.9	6.9	64	100	26–58	45.9
Operated mitral stenosis with restenosis or restenosis and insufficiency	6	100	39–66	48.5	10.2	0	-			—	6	100	39 66	48.5
1 a + b	47	67	26–66	46.6	8.2	23	33	32–57	44.9	6.9	70	100	26–66	46.1
…ned mitral stenosis and insufficiency	16	76	36 -61	48.4	7.1	5	24	34 55	46.8	8.9	21	100	34 61	48.0
…predominant mitral insufficiency	1	20	23	23.0	—	4	80	30–50	43.5	9.1	5	100	23 -50	39.4
1 + 2 + 3	64	67	23 66	46.7	8.4	32	33	30 57	45.0	7.3	96	100	23 66	46.2
					0.30 > p > 0.20									
Constrictive pericarditis	4	50	30–42	35.8	6.7	4	50	7–50	34.3	18.8	8	100	7 50	35.0
Pericardial effusion or cyst	0	—	—			0	—		-	—	0	—	—	–
4 a + b	4	50	30 42	35.8	6.7	4	50	7–50	34.3	18.8	8	100	7 50	35.0
1 + 2 + 3 + 4	**68**	65	**23–66**	**46.1**	8.7	**36**	35	**7 57**	**43.8**	9.4	**104**	100	**7 66**	**45.3**
Aortic stenosis	1	9	59	59.0	—	10	91	4–65	30.4	21.9	11	100	4–65	33.0
…mbined aortic stenosis and insufficiency	2	40	51–57	54.0		3	60	44 55	49.7		5	100	44–57	[illegible]
Aortic insufficiency	1	100	6	6.0	—	0	—	-	-	—	1	100	6	[illegible]
1 a + b + c	4	24	6 -59	43.3	25.1	13	76	4–65	34.8	20.9	17	100	4 -65	[illegible]
…ation of the aorta	0			—	—	1	100	4	4.0	—	1	100	4	4
…ashu's disease	1	100	17	17.0	—	0	—	—	—	-	1	100	17	17
1 + 2 + 3	5	26	6–59	38.0	24.7	14	74	4 -65	32.6	21.7	19	100	4–65	34.
…roelastosis cordis + aortic hypoplasia	0	-	—	-		0	—	—		—	0		—	
…ardial diseases other than cardiosclerosis	1	17	50	50.0	—	5	83	0.5–74	31.9	31.0	6	100	0.5–74	[illegible]
…osclerosis	0	—	-			9	100	41 72	54.7	10.3	9	100	41–72	[illegible]
4 a + b + c	1	7	50	50.0	—	14	93	0.5 -74	46.5	22.1	15	100	0.5–74	[illegible]
1 + 2 + 3 + 4	**6**	18	**6–59**	**40.0**	22.6	**28**	82	**0.5 -74**	**39.6**	22.6	**34**	100	**0.5 -74**	[illegible]
					p > 0.80									
Total sum	**98**	**52**	**0.75–66**	**42.3**		**90**	**48**	**0.2 -74**	**40.9**		**188**	**100**	**0.2 74**	**41.6**

Table 1. (Abbreviations: m = mean, sd = standard deviation)
The table summarizes the disorder groups and the pulmonary arterial pressure groups in the material. Males and females, and the sum of males and females are separately represented in each group (the percentage number indicates the proportion which the cases of either sex constitutes of the total number of cases in the same group), with mean, range and standard deviation of the age distribution. In groups where there was a significant difference of the age distribution between the female and the male cases, this is shown by indication of the significance level of the difference (* = 0.05 > p > 0.01 ; ** = 0.01 > p > 0.001 ; *** = p < 0.001). In the other groups, no significant difference was present. Differences in the age distribution between various pressure groups are not indicated in the table, but separately evaluated by regression analysis in the respective disease groups. Differences in the relative sex distribution between cases with normal pulmonary arterial pressure and the sum of cases with increased pulmonary arterial pressure within the respective disease groups are indicated in the table, however, by the inclusion of an additional vertical column between the "normal pulmonary arterial pressure" and "sum pulmonary hypertension" columns, showing the probability of sex distribution between them. In the main disorder group statistical evaluation was performed between all pressure gro… cases with normal pulmonary arterial pressure; and the findi… indicated by showing in each pressure group the probability o… sex distribution encountered.

Sd	Females Number Nr	Females Number %	Females Range	Females Age m	Females Age Sd	Males Number Nr	Males Number %	Males Range	Males Age m	Males Age Sd	F+M Number Nr	F+M Number %	F+M Range	F+M Age m	F+M Age Sd
3	43	51–56	52.3	—		2	57	5–50	29.8	—	7	100	5–56	39.4	19.2
2	40	0.17–0.33	0.25	—		3	60	3–22	11.7	—	5	100	0.17–22	7.1	9.2
3	75	25–52	41.7	—		1	25	4	4.0	—	4	100	4–52	32.3	22.3
8	50	0.17–56	35.3	23.6		8	50	3–50	19.8	18.3	16	100	0.17–56	27.5	21.9
1	25	0.02	0.02	—		3	75	0.05–0.5	0.3	—	4	100	0.02–0.5	0.2	0.2
9	45	0.02–56	31.4	25.0		11	55	0.05–50	14.4	17.8	20	100	0.02–56	22.1	22.5
0	—	—	—	—		0	—	—	—	—	0	—	—	—	—
0	—	—	—	—		1	100	49	49.0	—	1	100	49	49.0	—
0	—	—	—	—		0	—	—	—	—	0	—	—	—	—
0	—	—	—	—		0	—	—	—	—	0	—	—	—	—
0	—	—	—	—		1	100	49	49.0	—	1	100	49	49.0	—
9	43	**0.02–56**	**31.4**	25.0		12	57	**0.05–50**	**17.3**	19.7	**21**	100	**0.02–56**	**23.4**	22.7
				0.05>p>0.01											
2	50	**44–63**	**53.5**	—		**2**	**50**	**42–55**	**48.5**	—	**4**	100	**42–63**	**51.0**	9.8
		—	—	—		4	100	52–64	59.0	5.3	4	100	52–64	59.0	5.3
		—		—		2	100	49–63	56.0	—	2	100	49–63	56.0	—
				—		0	—	—	—	—	0	—	—	—	—
		—	—	—		0	—			—	0	—	—	—	—
						2	100	49–63	56.0	—	2	100	49–63	56.0	—
	—	—	—	—		1	100	47	47.0	—	1	100	47	47.0	—
		—		—		1	100	22	22.0	—	1	100	22	22.0	—
			—	—		0	—	—	—	—	0	—	—	—	—
	—	—	—	—		1	100	55	55.0	—	1	100	55	55.0	—
			—	—		2	100	22–55	38.5	—	2	100	22–55	38.5	—
		—		—		**9**	100	**22–64**	**52.4**	13.0	**9**	100	**22–64**	**52.4**	13.0
				0.20>p>0.10											
	71	21–63	45.0	8.2		19	29	22–62	48.3	10.5	66	100	21–63	45.8	9.2
	83	29–57	45.3	8.5		2	17	45–63	54.0	—	12	100	29–63	46.8	9.2
	73	21–63	44.9	8.6		21	27	22–63	48.6	10.3	78	100	21–63	45.9	9.1
	75	32–52	43.1	6.2		5	25	28–54	38.4	9.9	20	100	28–54	41.9	7.3
	25	49	49.0	-		3	75	8–56	29.3	—	4	100	8–56	34.3	22.2
	72	21–63	44.1	9.5		29	28	8–63	45.4	13.4	102	100	8–63	44.7	9.8
				0.10>p>0.05											
	13	45–62	53.5	—		4	67	20–54	35.5	16.2	6	100	20–62	41.5	16.5
				—		0	—		—		0	—		—	—
		45–62	53.5	—		12.0	67	20–54	35.5	16.2	6	100	20–62	41.5	16.5
	69	**21–63**	**44.9**	10.4		**33**	31	**8–63**	**43.8**	13.7	**108**	100	**8–63**	**44.5**	10.2
			—	—		1	100	65	65.0	—	1	100	65	65.0	—
	28		28.0			1	50	44	44.0	—	2	100	28–44	36.0	11.3
						4	100	30–64	44.5	14.2	4	100	30–64	44.5	14.2
	28		28.0	—		6	86	30–65	47.8	13.8	7	100	28–65	45.0	14.7
	7		7.0			0	—	—	—	—	1	100	7	7.0	—
				—		0	—	—	—	—	0	—	—	—	—
25	7	28	17.5	—		6	75	30–65	47.8	13.8	8	100	7–65	40.3	19.1
				—		0	—	—	—	—	0	—	—	—	—
				—		2	100	50–72	61.0	—	2	100	50–72	61.0	—
			—	—		5	100	50–71	58.8	9.3	5	100	50–71	58.8	9.3
				—		7	100	50–72	59.4	10.0	7	100	50–72	59.4	10.0
	13	**7–28**	**17.5****	—		**13**	87	**30–72**	**54.1****	12.9	**15**	100	**7–72**	**49.2**	18.0
				0.60>p>0.50											
	56	**0.02–63**	**43.1**			**69**	**44**	**0.05–72**	**42.4**		**157**	**100**	**0.02–72**	**42.7**	

Pronounced pulmonary hypertension (61–80 mm Hg)

Sd	Females Number Nr	Females Number %	Females Range	Females Age m	Females Age Sd	Males Number Nr	Males Number %	Males Range	Males Age m	Males Age Sd	F+M Number Nr	F+M Number %	F+M Range	F+M Age m	F+M Age Sd
	5	83	28–50	40.4	10.1	1	17	49	49.0	—	6	100	28–50	41.8	9.7
	2	50	0.2–11	5.6	—	2	50	2–27	14.5	—	4	100	0.2–27	10.1	12.2
	2	100	16–17	16.5	—	0	—	—	—	—	2	100	16–17	16.5	—
	9	75	0.2–50	27.4	17.7	3	25	2–49	26.0	—	12	100	0.2–50	27.0	18.1
	3	50	0.5–9	3.5	—	3	50	1–8	4.3	—	6	100	0.5–9	3.9	3.8
	12	67	0.2–50	21.4	18.7	6	33	1–49	15.2	19.2	18	100	0.2–50	19.3	18.5
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	12	67	**0.2–50**	**21.4**	18.7	**6**	33	**1–49**	**15.2**	19.2	**18**	100	**0.2–50**	**19.3**	18.5
					p>0.80										
	2	67	**36–56**	**46.0**	—	**1**	33	**45**	**45.0**	—	**3**	100	**36–56**	**45.7**	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	1	100	71	71.0	—	0	—	—	—	—	1	100	71	71.0	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	1	100	71	71.0	—	**0**	—	—	—	—	**1**	100	**71**	**71.0**	—
					0.10>p>0.05										
	6	40	36–61	44.5	9.8	9	60	27–55	45.0	9.2	15	100	27–61	44.8	9.1
	5	63	25–52	42.8	10.8	3	37	29–53	37.3	—	8	100	25–53	40.8	11.3
	11	48	25–61	43.7	9.8	12	52	27–55	43.1	10.4	23	100	25–61	43.4	9.9
	5	83	30–54	40.6	9.0	1	17	37	37.0	—	6	100	30–54	40.0	8.2
	0	—	—	—	—	2	100	36–56	46.0	—	2	100	36–56	46.0	—
	16	52	25–61	42.8	14.0	15	48	27–56	43.1	10.1	31	100	25–61	42.9	9.6
					0.50>p>0.40										
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	16	52	**25–61**	**42.8**	10.1	**15**	48	**27–56**	**43.1**	10.1	**31**	100	**25–61**	**42.9**	9.6
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	40–41	40.5	—	2	100	40–41	40.5	—
	1	50	42	42.0	—	1	50	44	44.0	—	2	100	42–44	43.0	—
	1	25	42	42.0	—	3	75	40–44	41.7	—	4	100	40–44	41.8	1.7
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	1	25	42	42.0	—	3	75	40–44	41.7	—	4	100	40–44	41.8	1.7
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	1	25	**42**	**42.0**	—	**3**	75	**40–44**	**41.7**	—	**4**	100	**40 44**	**41.8**	1.7
					0.80>p>0.70										
	32	**56**	**0.2–71**	**35.8**		**25**	**44**	**1–56**	**36.3**		**57**	**100**	**0.2–71**	**36.0**	

Severe pulmonary hypertension (≥81 mm Hg)

Sd	Females Number Nr	Females Number %	Females Range	Females Age m	Females Age Sd	Males Number Nr	Males Number %	Males Range	Males Age m	Males Age Sd	F+M Number Nr	F+M Number %	F+M Range	F+M Age m	F+M Age Sd
	1	100	37	37.0	—	0	—	—	—	—	1	100	37	37.0	—
	10	56	5–50	22.6	14.6	8	44	4–27	14.9	6.7	18	100	4–50	19.2	12.1
	6	67	7–32	19.8	9.8	3	33	0.8–32	12.9	—	9	100	0.8–32	17.5	11.9
	17	61	5–50	22.5	12.9	11	39	0.8–32	14.3	9.4	28	100	0.8–50	19.3	12.1
	1	50	20	20.0	—	1	50	0.5	0.5	—	2	100	0.5–20	10.3	—
	18	60	5–50	22.3*	12.5	12	40	0.5–32	13.2*	9.8	30	100	0.5–50	18.7	12.2
	2	100	44–48	46.0	—	0	—	—	—	—	2	100	44–48	46.0	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	1	100	45	45.0	—	0	—	—	—	—	1	100	45	45.0	—
	3	100	44–48	45.7	—	0	—	—	—	—	3	100	44–48	45.7	—
	21	64	**5–50**	**25.7***	14.3	**12**	36	**0.5–32**	**13.2***	9.8	**33**	100	**0.5–50**	**21.1**	14.0
					0.60>p>0.50										
	3	60	**13–63**	**42.7**	—	**2**	40	**6–33**	**29.5**	—	**5**	100	**6–63**	**37.4**	25.9
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	30–32	36.0	—	2	100	30–42	36.0	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	**2**	100	**30–42**	**36.0**	—	**2**	100	**30–42**	**36.0**	—
					0.50>p>0.40										
	13	72	23–56	41.2	9.9	5	28	29–58	44.8	10.7	18	100	23–58	42.2	10.0
	2	67	52–60	56.0	—	1	33	46	46.0	—	3	100	46–60	52.7	—
	15	71	23–60	43.2	10.7	6	29	29–58	45.0	9.6	21	100	23–60	43.7	10.2
	3	75	49–56	51.3	—	1	25	41	41.0	—	4	100	41–56	48.8	6.1
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	18	72	23–60	44.6	10.3	7	28	29–58	44.4	8.9	25	100	23–60	44.5	9.7
					0.30>p>0.20										
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	18	72	**23–60**	**44.6**	10.3	**7**	28	**29–58**	**44.4**	8.9	**25**	100	**23–60**	**44.5**	9.7
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	54–58	56.0	—	2	100	54–58	56.0	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	54–58	56.0	—	2	100	54–58	56.0	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	54–58	56.0	—	2	100	54–58	56.0	—
	0	—	—	—	—	1	100	0.08	0.08	—	1	100	0.08	0.08	—
	0	—	—	—	—	1	100	46	46	—	1	100	46	46	—
	0	—	—	—	—	0	—	—	—	—	0	—	—	—	—
	0	—	—	—	—	2	100	0.08–46	23.0	—	2	100	0.08–46	23.0	—
	0	—	—	—	—	**4**	100	**0.08–58**	**39.5**	26.8	**4**	100	**0.08–58**	**39.5**	26.8
					0.40>p>0.30										
	42	**61**	**5–63**	**35.0**		**27**	**39**	**0.08–58**	**28.1**		**69**	**100**	**0.08–63**	**32.3**	

Total material

	Number	Surviving n	%	Range (after n years)	m	Sd	Dead n	%	Range (after n years)	m	Sd	Lost n	%
I Shunt lesions													
1 Atrial septal defect	101	90	89	3–22	10.6	5.1	11	11	0.33–12	6.1	4.2	0	—
2 Ventricular septal defect	78	55	71	1–22	11.9	6.2	18	23	0–18	4.0	5.4	5	6
3 Persistent ductus arteriosus	85	73	86	3–22	13.6	6.2	11	13	0.04–10	2.5	3.3	1	1
1 + 2 + 3	264	218	83	1–22	11.9	5.9	40	15	0–18	4.2	4.7	6	2
4 Others (unassociated with pulmonary stenosis)	15	5	33	6–16	10.0	4.6	9	60	0.003–0.25	0.12	0.08	1	7
1 + 2 + 3 + 4	279	223	80	1–22	11.9	5.9	49	18	0–18	3.4	4.5	7	3
5 Extra-cardiac shunts													
a) Systemic arteriovenous fistula	4	1	25	4	4.0	—	3	75	0.5–2	1.2	—	0	—
b) Pulmonary arteriovenous fistula	4	3	75	4–21	10.7	—	1	25	2	2.0	—	0	—
c) Anomalous pulmonary venous return	7	6	86	4–15	11.7	3.9	1	14	0.25	0.25	—	0	—
d) The scimitar syndrome	3	1	33	11	11.0	—	2	67	1–3	2.0	—	0	—
5 a + b + c + d	18	11	61	4–21	10.6	5.4	7	39	0.25–3	1.4	1.0	0	—
1 + 2 + 3 + 4 + 5	297	234	79	1–22	11.8	5.8	56	19	0–18	3.2	4.3	7	2
II Primary and chronic thromboembolic pulmonary hypertension	13	6	46	0.5–11	5.3	4.4	7	54	0.5–5	2.2	1.8	0	—
III Lung disorders													
1 Chronic obstructive pulmonary disease	53	35	66	3–22	6.6	4.9	14	26	0.5–15	4.1	5.1	4	8
2 Pulmonary parenchymatous diseases													
a) Cancer	16	3	19	3–11	5.7	—	12	75	0.17–5	1.1	1.4	1	6
b) Tuberculosis	19	15	79	5–14	9.2	3.4	3	16	1–5	3.0	—	1	5
c) Others	11	11	100	3–8	4.5	1.7	0	—	—	—	—	0	—
2 a + b + c	46	29	63	3–14	7.1	3.7	15	33	0.17–5	1.5	3.7	2	4
3 Pulmonary fibrosis	5	0	—	—	—	—	5	100	0.5–3	1.4	0.96	0	—
4 Ventilatory disturbance													
a) Pes excavatum	11	9	82	3–14	10.2	3.6	1	9	0.025	0.025	—	1	9
b) Pleural diseases	8	6	75	2–14	7.3	5.1	2	25	0.75	0.75	—	0	—
c) Obesity	3	2	67	14–17	15.5	—	1	33	13	13.0	—	0	—
4 a + b + c	22	17	77	2–17	9.8	4.6	4	18	0.025–13	3.6	6.3	1	5
1 + 2 + 3 + 4	126	81	64	2–22	7.4	4.5	38	30	0.025–15	2.7	3.9	7	6
(1 + 2 + 3 + 4 — cancer and pleural malignancy)	108	78	72	2–22	7.7	4.7	24	22	0.025–15	3.6	4.5	6	6
IV Mitral valvular disease and heart constriction													
1 a) Pure or predominant mitral stenosis	234	147	63	3–21	10.2	5.0	80	34	0.08–20	6.3	5.3	7	3
b) Operated mitral stenosis with restenosis or restenosis and insufficiency	29	15	52	4–12	7.9	2.9	14	48	0.04–8	2.4	2.4	0	—
1 a + b	263	162	62	3–21	9.9	4.9	94	36	0.04–20	5.7	5.2	7	2
2 Combined mitral stenosis and insufficiency	63	31	49	3–19	9.5	4.8	28	45	0.06–10	3.5	3.2	4	6
3 Pure or predominant mitral insufficiency	20	8	40	6–20	10.0	4.7	12	60	0.17–19	4.5	5.4	0	—
1 + 2 + 3	346	201	58	3–21	9.9	4.8	134	39	0.04–20	5.1	4.9	11	3
4 a) Constrictive pericarditis	24	14	58	4–20	10.8	4.8	10	42	0.08–16	4.2	5.9	0	—
b) Pericardial effusion or cyst	5	2	40	9–10	9.5	—	2	40	0.08–2	1.0	—	1	20
4 a + b	29	16	55	4–20	10.6	4.5	12	41	0.08–16	3.7	5.5	1	4
1 + 2 + 3 + 4	375	217	58	3–21	10.0	4.8	146	39	0.04–20	5.0	4.9	12	3
V Disorders of the left heart													
1 Aortic valvular disease													
a) Aortic stenosis	33	17	52	3–21	11.4	4.8	14	42	1–15	7.0	4.9	2	6
b) Combined aortic stenosis and insufficiency	16	7	44	5–8	6.9	1.5	9	56	0.04–13	3.2	4.3	0	—
c) Aortic insufficiency	29	17	59	3–19	8.5	4.4	12	41	0.08–15	3.8	4.7	0	—
1 a + b + c	78	41	53	3–21	9.4	4.5	35	45	0.08–15	4.9	4.5	2	2
2 Coarctation of the aorta	20	19	95	4–23	10.6	5.1	0	—	—	—	—	1	5
3 Takayashu's disease	1	0	—	—	—	—	1	100	0.25	0.25	—	0	—
1 + 2 + 3	99	60	61	3–23	9.8	4.7	36	36	0.08–15	4.8	4.9	3	3
4 a) Fibroelastosis cordis + aortic hypoplasia	1	0	—	—	—	—	1	100	0.003	0.003	—	0	—
b) Myocardial diseases other than cardiosclerosis	25	16	64	4–23	11.1	6.2	9	36	0.17–8	3.3	3.2	0	—
c) Cardiosclerosis	96	58	60	3–15	5.4	2.1	38	40	0.01–6	1.9	1.7	0	—
4 a + b + c	122	74	61	3–23	6.7	4.1	48	39	0.003–8	2.1	2.1	0	—
1 + 2 + 3 + 4	221	134	61	3–23	8.1	4.6	84	38	0.003–15	3.3	3.8	3	1
Total sum	1032	672	65	0.5–23	9.9		331	32	0–20	3.9		29	3

Normal systolic pulmonary arterial pressure (≤ 30 mm Hg)

	Number	Surviving n	%	Range (after n years)	m	Sd	Dead n	%	Range (after n years)	m	Sd	Lost n	%	p
I Shunt lesions														
1 Atrial septal defect	75	73	97	3–22	10.8	5.1	2	3	2–10	6.0	—	0	—	p<0.0005
2 Ventricular septal defect	46	42	92	3–22	11.3	5.7	2	4	0–9	4.5	—	2	4	p<0.0005
3 Persistent ductus arteriosus	61	60	98	3–22	13.1	6.3	1	2	10	10.0	—	0	—	p<0.0005
1 + 2 + 3	182	175	96	3–22	11.6	5.7	5	3	0–10	6.2	4.8	2	1	p<0.0005
4 Others (unassociated with pulmonary stenosis)	2	1	50	14	14.0	—	1	50	0.03	0.03	—	0	—	p>0.5
1 + 2 + 3 + 4	184	176	96	3–22	11.7	5.7	6	3	0–10	5.2	5.0	2	1	p<0.0005
5 Extra-cardiac shunts														
a) Systemic arteriovenous fistula	2	1	50	4	4.0	—	1	50	0.5	0.5	—	0	—	0.3>p>0.2
b) Pulmonary arteriovenous fistula	3	3	100	4–21	10.7	9.1	0	—	—	—	—	0	—	0.05>p>0.01
c) Anomalous pulmonary venous return	7	6	86	4–15	11.7	3.9	1	14	0.25	0.25	—	0	—	—
d) The scimitar syndrome	0	0	—	—	—	—	0	—	—	—	—	0	—	—
5 a + b + c + d	12	10	83	4–21	10.6	5.7	2	17	0.25–0.5	0.4	—	0	—	0.01>p>0.005
1 + 2 + 3 + 4 + 5	196	186	95	3–22	11.6	5.7	8	4	0–10	4.0	4.8	2	1	p<0.0005
II Primary and chronic thromboembolic pulmonary hypertension	0	0	—	—	—	—	0	—	—	—	—	0	—	—
III Lung disorders														
1 Chronic obstructive pulmonary disease	40	30	75	3–22	6.8	5.3	8	20	0.5–15	4.3	5.5	2	5	0.05>p>0.01
2 Pulmonary parenchymatous diseases														
a) Cancer	10	3	30	3–11	5.7	4.6	6	60	0.17–5	1.5	1.8	1	10	0.2>p>0.1
b) Tuberculosis	17	13	76	5–14	9.1	3.5	3	18	1–5	3.0	—	1	6	0.5>p>0.4
c) Others	11	11	100	3–8	4.5	1.7	0	—	—	—	—	0	—	—
2 a + b + c	38	27	71	3–14	6.9	3.7	9	24	0.17–5	2.0	1.9	2	5	0.01>p>0.005
3 Pulmonary fibrosis	1	0	—	—	—	—	1	100	0.5	0.5	—	0	—	—
4 Ventilatory disturbance														
a) Pes excavatum	10	9	90	3–14	10.2	3.6	0	—	—	—	—	1	10	0.005>p>0.0005
b) Pleural diseases	4	4	100	3–14	7.3	4.8	0	—	—	—	—	0	—	0.2>p>0.1
c) Obesity	1	1	100	17	17.0	—	0	—	—	—	—	0	—	0.4>p>0.3
4 a + b + c	15	14	93	3–17	9.9	4.4	0	—	—	—	—	1	7	0.005>p>0.0005
1 + 2 + 3 + 4	94	71	76	3–22	7.4	4.6	18	19	0.17–15	2.9	4.0	5	5	p<0.0005
(1 + 2 + 3 + 4 — cancer and pleural malignancy)	84	68	81	3–22	7.5	4.7	12	14	0.5–15	3.6	4.7	4	5	p<0.0005
IV Mitral valvular disease and heart constriction														
1 a) Pure or predominant mitral stenosis	71	53	75	3–21	9.7	5.4	17	24	0.25–20	7.5	5.3	1	1	0.05>p>0.01
b) Operated mitral stenosis with restenosis or restenosis and insufficiency	0	0	—	—	—	—	0	—	—	—	—	0	1	—
1 a + b	71	53	75	3–21	9.7	5.4	17	24	0.25–20	7.5	5.3	1	1	0.05>p>0.001
2 Combined mitral stenosis and insufficiency	12	9	75	4–19	10.7	5.4	3	25	2–10	5.3	—	0	—	0.1>p>0.05
3 Pure or predominant mitral insufficiency	9	6	67	6–20	11.0	5.1	3	33	0.33–3	1.8	—	0	—	0.05>p>0.01
1 + 2 + 3	92	68	74	3–21	10.0	5.3	23	25	0.25–20	6.4	5.1	1	1	0.005>p>0.0005
4 a) Constrictive pericarditis	10	6	60	4–20	10.8	5.3	4	40	0.24–3	1.2	1.3	0	—	p>0.5
b) Pericardial effusion or cyst	5	2	40	9–10	9.5	0.7	2	40	0.08–2	1.0	—	1	20	—
4 a + b	15	8	53	4–20	10.5	4.5	6	40	0.08–3	1.1	1.1	1	7	p=1
1 + 2 + 3 + 4	107	76	71	3–21	10.0	5.2	29	27	0.08–20	5.3	5.1	2	2	0.005>p>0.0005
V Disorders of the left heart														
1 Aortic valvular disease														
a) Aortic stenosis	21	12	57	5–21	11.4	5.0	7	33	1–15	9.7	4.8	2	10	0.3>p>0.2
b) Combined aortic stenosis and insufficiency	5	3	60	6–8	7.3	1.2	2	40	0.08–13	6.5	—	0	—	0.4>p>0.3
c) Aortic insufficiency	22	16	73	3–19	8.8	4.4	6	27	1–15	7.0	4.9	0	—	0.01>p>0.005
1 a + b + c	48	31	65	3–21	9.6	4.8	15	31	0.08–15	8.2	5.1	2	4	0.005>p>0.0005
2 Coarctation of the aorta	18	17	94	4–23	10.6	5.4	0	—	—	—	—	1	6	—
3 Takayashu's disease	0	0	—	—	—	—	0	—	—	—	—	0	—	—
1 + 2 + 3	66	48	73	3–23	10.0	4.9	15	23	0.08–15	8.2	5.1	3	4	p<0.0005
4 a) Fibroelastosis cordis + aortic hypoplasia	0	0	—	—	—	—	0	—	—	—	—	0	—	—
b) Myocardial diseases other than cardiosclerosis	16	12	75	7–23	12.3	6.3	4	25	1–8	5.3	3.1	0	—	0.2>p>0.1
c) Cardiosclerosis	82	52	63	3–9	5.3	1.6	30	37	0.04–6	2.1	1.8	0	—	0.2>p>0.1
4 a + b + c	98	64	65	3–23	6.6	4.1	34	35	0.04–8	2.4	2.2	0	—	0.05>p>0.01
1 + 2 + 3 + 4	164	112	68	3–23	8.1	4.9	49	30	0.04–15	4.2	4.3	3	2	p<0.0005
Total sum	561	445	79	3–23	9.8		104	19	0–20	4.3		12	2	p<0.0005

Sum Pulmonary hypertension (≥ 31 mm Hg)

	Number	Surviving n	%	Range (after n years)	m	Sd	Dead n	%	Range (after n years)	m	Sd	Lost n	%
I Shunt lesions													
1 Atrial septal defect	26	17	65	3–20	9.8	4.8	9	35	0.33–12	6.1	4.2	0	—
2 Ventricular septal defect	32	13	41	1–22	13.7	7.4	16	50	0.03–18	3.9	5.5	3	9
3 Persistent ductus arteriosus	24	13	54	6–22	16.1	5.5	10	42	0.04–7	1.8	2.4	1	4
1 + 2 + 3	82	43	52	1–22	12.9	6.4	35	43	0.03–12	3.9	4.6	4	5
4 Others (unassociated with pulmonary stenosis)	13	4	31	6–16	9.0	4.7	8	62	0.003–0.25	0.13	0.08	1	7
1 + 2 + 3 + 4	95	47	50	1–22	12.5	6.3	43	45	0.003–18	3.2	4.4	5	5
5 Extra-cardiac shunts													
a) Systemic arteriovenous fistula	2	0	—	—	—	—	2	100	1–2	1.5	—	0	—
b) Pulmonary arteriovenous fistula	1	0	—	—	—	—	1	100	2	2.0	—	0	—
c) Anomalous pulmonary venous return	0	0	—	—	—	—	0	—	—	—	—	0	—
d) The scimitar syndrome	3	1	33	11	11.0	—	2	67	1–3	2.0	—	0	—
5 a + b + c + d	6	1	17	11	11.0	—	5	83	1–3	1.8	0.8	0	—
1 + 2 + 3 + 4 + 5	101	48	48	1–22	12.5	6.2	48	48	0.003–18	3.0	4.2	5	4
II Primary and chronic thromboembolic pulmonary hypertension	13	6	46	0.5–11	5.3	4.4	7	54	0.5–5	2.2	1.8	0	—
III Lung disorders													
1 Chronic obstructive pulmonary disease	13	5	38	5–6	5.2	0.4	6	46	0.5–13	3.9	4.9	2	16
2 Pulmonary parenchymatous diseases													
a) Cancer	6	0	—	—	—	—	6	100	0.17–1.5	0.7	0.5	0	—
b) Tuberculosis	2	2	100	8–12	10.0	—	0	—	—	—	—	0	—
c) Others	0	0	—	—	—	—	0	—	—	—	—	0	—
2 a + b + c	8	2	25	8–12	10.0	—	6	75	0.17–1.5	0.7	0.5	0	—
3 Pulmonary fibrosis	4	0	—	—	—	—	4	100	1–3	1.6	0.95	0	—
4 Ventilatory disturbance													
a) Pes excavatum	1	0	—	—	—	—	1	100	0.025	0.025	—	0	—
b) Pleural diseases	4	2	50	2–13	7.5	—	2	50	0.75	0.75	—	0	—
c) Obesity	2	1	50	14	14.0	—	1	50	13	13.0	—	0	—
4 a + b + c	7	3	43	2–14	9.7	—	4	57	0.025–13	3.6	6.3	0	—
1 + 2 + 3 + 4	32	10	31	2–14	7.5	4.1	20	63	0.025–13	2.4	3.8	2	6
(1 + 2 + 3 + 4 — cancer and pleural malignancy)	24	10	42	2–14	7.5	4.1	12	50	0.025–13	3.6	4.7	2	8
IV Mitral valvular disease and heart constriction													
1 a) Pure or predominant mitral stenosis	163	94	58	3–21	10.5	4.8	63	39	0.08–18	5.9	5.3	6	3
b) Operated mitral stenosis with restenosis or restenosis and insufficiency	29	15	52	4–12	7.9	2.9	14	48	0.04–8	2.4	2.4	0	—
1 a + b	192	109	57	3–21	10.1	4.7	77	40	0.04–18	5.3	5.1	6	3
2 Combined mitral stenosis and insufficiency	51	22	43	3–17	9.0	4.5	25	49	0.06–10	3.2	3.1	4	8
3 Pure or predominant mitral insufficiency	11	2	18	6–8	7.0	1.4	9	82	0.17–19	5.4	6.0	0	—
1 + 2 + 3	254	133	52	3–21	9.9	4.6	111	44	0.04–19	4.8	4.8	10	4
4 a) Constrictive pericarditis	14	8	57	5–18	10.8	4.8	6	43	0.08–16	6.3	7.1	0	—
b) Pericardial effusion or cyst	0	0	—	—	—	—	0	—	—	—	—	0	—
4 a + b	14	8	57	5–18	10.8	4.8	6	43	0.08–16	6.3	7.1	0	—
1 + 2 + 3 + 4	268	141	53	3–21	10.0	4.6	117	44	0.04–19	4.9	4.9	10	3
V Disorders of the left heart													
1 Aortic valvular disease													
a) Aortic stenosis	12	5	42	3–16	11.2	5.0	7	58	1–10	4.3	3.6	0	—
b) Combined aortic stenosis and insufficiency	11	4	36	5–8	6.5	1.7	7	64	0.04–8	2.3	2.5	0	—
c) Aortic insufficiency	7	1	14	5	5.0	—	6	86	0.08–2	0.58	0.72	0	—
1 a + b + c	30	10	33	3–16	8.7	4.4	20	67	0.08–10	2.5	3.0	0	—
2 Coarctation of the aorta	2	2	100	9–11	10.0	—	0	—	—	—	—	0	—
3 Takayashu's disease	1	0	—	—	—	—	1	100	0.25	0.25	—	0	—
1 + 2 + 3	33	12	36	3–16	8.9	4.0	21	64	0.08–10	2.3	2.9	0	—
4 a) Fibroelastosis cordis + aortic hypoplasia	1	0	—	—	—	—	1	100	0.003	0.003	—	0	—
b) Myocardial diseases other than cardiosclerosis	9	4	44	4–14	7.3	4.6	5	56	0.17–6	1.8	2.5	0	—
c) Cardiosclerosis	14	6	43	3–15	6.5	4.5	8	57	0.01–3	1.3	1.3	0	—
4 a + b + c	24	10	42	3–15	6.8	4.3	14	58	0.003–6	1.4	1.7	0	—
1 + 2 + 3 + 4	57	22	39	3–16	8.0	4.3	35	61	0.003–10	1.9	2.5	0	—
Total sum	471	227	48	0.5–22	10.1		227	48	0.003–19	3.7		17	4

Slightly elevated systolic pulmonary arterial pressure (31–40 mm Hg)

	Number	Surviving n	%	Range (after n years)	m	Sd	Dead n	%	Range (after n years)	m	Sd	Lost n	%	p
I Shunt lesions														
1 Atrial septal defect	12	9	75	3–20	11.2	6.0	3	25	0.33–9	4.4	—	0	—	
2 Ventricular septal defect	5	3	60	7–22	13.0	—	2	40	0.06–0.08	0.07	—	0	—	
3 Persistent ductus arteriosus	9	7	78	13–22	19.0	3.6	1	11	0.04	0.04	—	1	11	
1 + 2 + 3	26	19	73	3–22	14.4	6.4	6	23	0.04–9	2.3	3.7	1	4	
4 Others (unassociated with pulmonary stenosis)	1	1	100	16	16.0	—	0	—	—	—	—	0	—	
1 + 2 + 3 + 4	27	20	74	3–22	14.5	6.2	6	22	0.04–9	2.3	3.7	1	4	
5 Extra-cardiac shunts														
a) Systemic arteriovenous fistula	0	0	—	—	—	—	0	—	—	—	—	0	—	
b) Pulmonary arteriovenous fistula	0	0	—	—	—	—	0	—	—	—	—	0	—	
c) Anomalous pulmonary venous return	0	0	—	—	—	—	0	—	—	—	—	0	—	
d) The scimitar syndrome	2	1	50	11	11.0	—	1	50	3	3.0	—	0	—	
5 a + b + c + d	2	1	50	11	11.0	—	1	50	3	3.0	—	0	—	
1 + 2 + 3 + 4 + 5	29	21	72	3–22	13.3	6.6	7	24	0.04–9	2.4	3.3	1	4	(Chi square=16,9); p<0.0005.
II Primary and chronic thromboembolic pulmonary hypertension	1	1	100	5	5.0	—	0	—	—	—	—	0	—	
III Lung disorders														
1 Chronic obstructive pulmonary disease	9	4	44	5–6	5.3	0.5	3	33	1–6	3.0	—	2	23	
2 Pulmonary parenchymatous diseases														
a) Cancer	4	0	—	—	—	—	4	100	0.17–1.5	0.86	0.55	0	—	
b) Tuberculosis	2	2	100	8–12	10.0	—	0	—	—	—	—	0	—	
c) Others	0	0	—	—	—	—	0	—		—	—	0	—	
2 a + b + c	6	2	33	8–12	10.0	—	4	67	0.17–1.5	0.86	0.55	0	—	
3 Pulmonary fibrosis	0	0	—	—	—	—	0	—	—	—	—	0	—	
4 Ventilatory disturbance														
a) Pes excavatum	0	0	—	—	—	—	0	—	—	—	—	0	—	
b) Pleural diseases	4	2	50	2–13	7.5	—	2	50	0.75	0.75	—	0	—	
c) Obesity	1	1	100	14	14.0	—	0	—	—	—	—	0	—	
4 a + b + c	5	3	60	2–14	9.7	—	2	40	0.75	0.75	—	0	—	
1 + 2 + 3 + 4	20	9	45	2–14	7.8	4.2	9	45	0.17–6	1.5	1.7	2	10	0.01>p>0.005
(1 + 2 + 3 + 4 — cancer and pleural malignancy)	14	9	64	2–14	7.8	4.2	3	22	1–6	3.0	—	2	14	
IV Mitral valvular disease and heart constriction														
1 a) Pure or predominant mitral stenosis	64	42	66	3–20	9.3	4.0	21	33	0.33–18	6.7	5.9	1	1	
b) Operated mitral stenosis with restenosis or restenosis and insufficiency	6	5	83	6–9	7.2	1.6	1	17	8	8.0	—	0	—	
1 a + b	70	47	67	3–20	9.1	3.9	22	32	0.33–18	6.7	5.7	1	1	
2 Combined mitral stenosis and insufficiency	21	13	62	3–17	9.1	5.0	6	29	0.17–7	3.0	2.6	2	9	
3 Pure or predominant mitral insufficiency	5	0	—	—	—	—	5	100	1.5–7	3.1	2.4	0	—	
1 + 2 + 3	96	60	63	3–20	9.1	4.1	33	34	0.17–18	5.5	5.1	3	3	0.2>p>0.1
4 a) Constrictive pericarditis	8	3	38	10–18	13.2	4.4	5	62	0.08–16	6.1	7.9	0	—	
b) Pericardial effusion or cyst	0	0	—	—	—	—	0	—	—	—	—	0	—	
4 a + b	8	3	38	10–18	13.2	4.4	5	62	0.08–16	6.1	7.9	0	—	
1 + 2 + 3 + 4	104	63	61	3–20	9.3	4.2	38	36	0.08–18	5.6	5.4	3	3	
V Disorders of the left heart														
1 Aortic valvular disease														
a) Aortic stenosis	11	5	45	3–16	11.2	5.0	6	55	1–10	4.7	3.8	0	—	
b) Combined aortic stenosis and insufficiency	5	3	60	5–8	7.0	—	2	40	0.04–4	2.0	—	0	—	
c) Aortic insufficiency	1	0	—	—	—	—	1	100	2	2.0	—	0	—	
1 a + b + c	17	8	47	3–16	9.6	4.4	9	53	0.04–10	3.8	3.5	0	—	
2 Coarctation of the aorta	1	1	100	9	9.0	—	0	—	—	—	—	0	—	
3 Takayashu's disease	1	0	—	—	—	—	1	100	0.25	0.25	—	0	—	
1 + 2 + 3	19	9	47	3–16	9.6	4.2	10	53	0.04–10	3.4	3.4	0	—	
4 a) Fibroelastosis cordis + aortic hypoplasia	0	0	—	—	—	—	0	—	—	—	—	0	—	
b) Myocardial diseases other than cardiosclerosis	6	3	50	4–6	5.0	—	3	50	0.17–6	2.7	—	0	—	
c) Cardiosclerosis	9	6	67	3–15	6.5	4.5	3	33	0.08–3	1.7	—	0	—	
4 a + b + c	15	9	60	3–15	6.0	3.7	6	40	0.08–6	2.2	2.2	0	—	
1 + 2 + 3 + 4	34	18	53	3–16	7.8	4.2	16	47	0.08–10	3.0	3.0	0	—	0.1>p> 0.05
Total sum	188	112	60	2–22	9.7		70	37	0.04–18	4.2		6	3	(Chi square=28.7); p<0.0005.

Moderate pulmonary hypertension (41–60 mm Hg)

	Number	Surviving n	%	Range (after n years)	m	Sd	Dead n	%	Range (after n years)	m	p
I Shunt lesions											
1 Atrial septal defect	7	6	86	5–12	7.5	2.6	1	14	12	12.0	
2 Ventricular septal defect	5	2	40	3–16	9.5	—	2	40	0.03–0.25	0.14	
3 Persistent ductus arteriosus	4	3	75	6–13	10.3	—	1	25	7	7.0	
1 + 2 + 3	16	11	69	3–16	8.6	4.1	4	25	0.03–12	4.8	
4 Others (unassociated with pulmonary stenosis)	4	0	—	—	—	—	4	100	0.003–0.25	0.13	
1 + 2 + 3 + 4	20	11	55	3–16	8.6	4.1	8	40	0.003–12	2.5	
5 Extra-cardiac shunts											
a) Systemic arteriovenous fistula	0	0	—	—	—	—	0	—	—	—	
b) Pulmonary arteriovenous fistula	1	0	—	—	—	—	1	100	2	2.0	
c) Anomalous pulmonary venous return	0	0	—	—	—	—	0	—	—	—	
d) The scimitar syndrome	0	0	—	—	—	—	0	—	—	—	
5 a + b + c + d	1	0	—	—	—	—	1	100	2	2.0	
1 + 2 + 3 + 4 + 5	21	11	52	3–16	8.6	4.1	9	43	0.003–12	2.4	(Chi square=41.4); p<0.0005
II Primary and chronic thromboembolic pulmonary hypertension	4	3	75	4–11	8.3	—	1	25	4	4.0	
III Lung disorders											
1 Chronic obstructive pulmonary disease	4	1	25	5	5.0	—	3	75	0.5–13	4.8	
2 Pulmonary parenchymatous diseases											
a) Cancer	2	0	—	—	—	—	2	100	0.25–0.5	0.38	
b) Tuberculosis	0	0	—	—	—	—	0	—	—	—	
c) Others	0	0	—	—	—	—	0	—	—	—	
2 a + b + c	2	0	—	—	—	—	2	100	0.25–0.5	0.33	
3 Pulmonary fibrosis	1	0	—	—	—	—	1	100	1.5	1.5	
4 Ventilatory disturbance											
a) Pes excavatum	1	0	—	—	—	—	1	100	0.025	0.02	
b) Pleural diseases	0	0	—	—	—	—	0	—	—	—	
c) Obesity	1	0	—	—	—	—	1	100	13	13.0	
4 a + b + c	2	0	—	—	—	—	2	100	0.025–13	6.5	
1 + 2 + 3 + 4	9	1	11	5	5.0	—	8	89	0.025–13	3.7	p<0.0005
(1 + 2 + 3 + 4 — cancer and pleural malignancy)	7	1	14	5	5.0	—	6	86	0.025–13	4.8	
IV Mitral valvular disease and heart constriction											
1 a) Pure or predominant mitral stenosis	66	39	59	3–20	10.6	4.8	25	38	0.17–17	5.8	
b) Operated mitral stenosis with restenosis or restenosis and insufficiency	12	9	75	4–12	8.6	3.3	3	25	0.5–3	1.7	
1 a + b	78	48	62	3–20	10.2	4.6	28	36	0.17–17	6.0	
2 Combined mitral stenosis and insufficiency	20	7	35	5–15	9.7	4.3	12	60	0.25–10	3.8	
3 Pure or predominant mitral insufficiency	4	1	25	6	6.0	—	3	75	0.17–19	7.7	
1 + 2 + 3	102	56	55	3–20	10.1	4.5	43	42	0.17–19	5.5	0.05>p>0.001
4 a) Constrictive pericarditis	6	5	83	5–18	9.3	4.9	1	17	7	7.0	
b) Pericardial effusion or cyst	0	0	—	—	—	—	0	—	—	—	
4 a + b	6	5	83	5–18	9.3	4.9	1	17	7	7.0	
1 + 2 + 3 + 4	108	61	56	3–20	10.0	4.5	44	41	0.17–19	5.5	
V Disorders of the left heart											
1 Aortic valvular disease											
a) Aortic stenosis	1	0	—	—	—	—	1	100	2	2.0	
b) Combined aortic stenosis and insufficiency	2	1	50	5	5.0	—	1	50	7	7.0	
c) Aortic insufficiency	4	0	—	—	—	—	4	100	0.17–0.5	0.3	
1 a + b + c	7	1	14	5	5.0	—	6	86	0.17–7	1.7	
2 Coarctation of the aorta	1	1	100	11	11.0	—	0	—	—	—	
3 Takayashu's disease	0	0	—	—	—	—	0	—	—	—	
1 + 2 + 3	8	2	25	5–11	8.0	—	6	75	0.17–7	1.7	
4 a) Fibroelastosis cordis + aortic hypoplasia	0	0	—	—	—	—	0	—	—	—	
b) Myocardial diseases other than cardiosclerosis	2	1	50	14	14.0	—	1	50	0.5	0.5	
c) Cardiosclerosis	5	0	—	—	—	—	5	100	0.01–3	1.1	
4 a + b + c	7	1	14	14	14.0	—	6	86	0.01–3	1.0	
1 + 2 + 3 + 4	15	3	20	5–14	10.0	—	12	80	0.01–7	1.4	p<0.0005
Total sum	157	79	50	3–20	9.7		74	47	0.003–19	4.2	(Chi square=54.7): p<0.0005

Table 2. (Abbreviations and symbols: n = number, % = percentage of cases in comparison with total number of cases in the same group, "after n years" = the duration of survival or until death after the time of cathete-

Like table 1, the table is divided into three main sections; to the left all cases within the various disease groups are summed up, in the middle section the cases with normal systolic pulmonary arterial pressure are compared with the sum of patients with various degree of pulmonary hypertension, and to the right the latter cases are subdivided in consecutive

groups as table 1, except for an additional horisontal column representing the sum of cases in the lung disorder group minus those primarily investigated on behalf of intrapulmonary or pleural malignancy.
In the table, results of follow-up investigation regarding survival and morta-

until death in the cases in the various groups are given. The sig
level of differences in survival-mortality between the cases with
pulmonary arterial pressure and the sum of patients with pulmonar
pressure increase is indicated

Lost		Pronounced pulmonary hypertension (61–80 mm Hg)													Severe pulmonary hypertension (≥81 mm Hg)												
			Surviving after n years					Dead after n years					Lost			Surviving after n years					Dead after n years					Lost	
n	%	Number	n	%	Range	m	Sd	n	%	Range	m	Sd	n	%	Number	n	%	Range	m	Sd	n	%	Range	m	Sd	n	%
0	—	6	2	33	10	10.0	—	4	67	2–11	5.3	4.0	0	—	1	0	—	—	—	—	1	100	9	9.0	—	0	—
1	20	4	1	25	22	22.0	—	3	75	0.08–2	1.0	—	0	—	18	7	39	1–21	14.0	7.5	9	50	0.5–18	6.6	6.2	2	11
0	—	2	2	100	7–19	13.0	—	0	—		—	—	0	—	9	1	11	19	19.0	—	8	89	0.08–5	1.4	1.6	0	—
1	9	12	5	42	7–22	13.6	6.5	7	58	0.08–11	3.4	3.7	0	—	28	8	29	1–21	14.6	7.2	18	64	0.08–18	4.4	5.2	2	7
0	—	6	2	33	6–7	6.5	—	3	50	0.06–0.17	0.13	—	1	17	2	1	50	7	7.0	—	1	50	0.17	0.17	—	0	—
1	5	18	7	39	6–22	11.6	6.3	10	56	0.06–11	2.4	3.4	1	5	30	9	30	1–21	13.8	7.2	19	63	0.08–18	4.2	5.1	2	7
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	2	0	—	—	—	—	2	100	1–2	1.5	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	1	0	—	—	—	—	1	100	1	1.0	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	3	0	—	—	—	—	3	100	1–2	1.3	—	0	—
1	5	**18**	**7**	39	**6–22**	**11.6**	6.3	**10**	56	**0.06–11**	**2.4**	3.4	**1**	5	**33**	**9**	27	**1–21**	**13.8**	7.2	**22**	67	**0.08–18**	**3.8**	4.9	**2**	6
			(Chi square=59.9); p<0.0005.													(Chi square=103,4); p<0.0005.											
0	—	**3**	**1**	33	**0.5**	**0.5**	—	**2**	67	**1**	**1.0**	—	**0**	—	**5**	**1**	20	**1**	**1.0**	—	**4**	80	**0.5–5**	**2.4**	2.1	**0**	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	1	0	—	—	—	—	1	100	1	1.0	—	0	—	2	0	—	—	—	—	2	100	1–3	2.0	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	**1**	**0**	—	—	—	—	**1**	100	**1**	**1.0**	—	**0**	—	**2**	**0**	—	—	—	—	2	100	**1–3**	**2.0**	—	**0**	—
			0.1>p>0.05													0.01>p>0.005.											
0	—	1	0	—	—	—	—	1	100	1	1.0	—	0	—	2	0	—	—	—	—	2	100	1–3	2.0	—	0	—
2	3	15	5	33	8–17	13.6	3.6	8	53	0.08–12	4.0	4.1	2	14	18	8	44	5–21	14.3	6.9	9	50	0.5–13	4.5	4.9	1	6
0	—	8	1	13	5	5.0	—	7	87	0.04–5	2.0	2.0	0	—	3	0	—	—	—	—	3	100	0.5–5	2.2	—	0	—
2	[illegible]	23	6	26	5–17	12.2	4.8	15	65	0.04–12	3.0	3.4	2	9	21	8	38	5–21	14.3	6.9	12	57	0.5–13	3.9	4.5	1	5
1	5	6	1	17	6	6.0	—	4	66	0.8–10	3.8	4.3	1	17	4	1	25	6	6.0	—	3	75	0.06–1.5	0.63	—	0	—
0	—	2	1	50	8	8.0	—	1	50	10.0	10.0	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
3	3	31	8	26	5–17	10.9	4.7	20	65	0.04–12	3.5	3.7	3	9	25	9	36	5–21	13.3	7.1	15	60	0.06–13	3.3	4.2	1	4
			p<0.0005													0.005>p>0.0005											
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
2	3	31	**8**	26	**5–17**	**10.9**	4.7	**20**	65	**0.04–12**	**3.5**	3.7	3	9	**25**	**9**	36	**5–21**	**13.3**	7.1	**15**	60	**0.06–13**	**3.3**	4.2	**1**	4
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	2	0	—	—	—	—	2	100	0.05–1	0.5	—	0	—	2	0	—	—	—	—	2	100	2	2.0	—	0	—
0	—	2	1	50	5	5.0	—	1	50	0.08	0.08	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	4	1	25	5	5.0	—	3	75	0.05–1	0.38	—	0	—	2	0	—	—	—	—	2	100	2	2.0	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	4	1	25	5	5.0	—	3	75	0.05–1	0.38	—	0	—	2	0	—	—	—	—	2	100	2	2.0	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	1	0	—	—	—	—	1	100	0.003	0.03	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	1	0	—	—	—	—	1	100	0.25	0.25	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	0	0	—	—	—	—	0	—	—	—	—	0	—
0	—	0	0	—	—	—	—	0	—	—	—	—	0	—	2	0	—	—	—	—	2	100	0.003–0.25	0.13	—	0	—
0	—	4	**1**	25	**5**	**5.0**	—	**3**	75	**0.05–1**	**0.38**	—	**0**	—	**4**	**0**	—	—	—	—	**4**	100	**0.003–2**	**1.1**	1.1	**0**	—
			0.1>p>0.05													0.005>p>0.0005											
4	3	57	**17**	**30**	**0.5–22**	**10.2**		**36**	**63**	**0.04–12**	**3.0**		**4**	**7**	**69**	**19**	**28**	1–21	12.9		**47**	**68**	**0.003–18**	**3.2**		**3**	**4**
			(Chi square=65); p<0.0005													(Chi square=86.9); p<0.0005.											

them. In the main disorder groups and in the material as a whole, the same statistical evaluation was performed between all pressure groups and the cases with normal pulmonary arterial pressure, and the findings similarly indicated by showing in each pressure group the probability of the compa-